This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

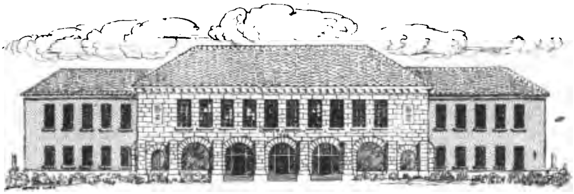
TX 744.1 .G232 PT.1
Garin, Paul Achille.
Outlines of industrial drawing. : An ele
Stanford University Libraries
3 6105 04931 4722

OUTLINES
OF
INDUSTRIAL DRAWING.

PART I.

PAUL A. GARIN.

E. Thos. Adams.
3 Heustis St.
Ithaca
[illegible]



SCHOOL OF EDUCATION
LIBRARY

TEXTBOOK COLLECTION
GIFT OF
THE PUBLISHERS

STANFORD UNIVERSITY
LIBRARIES

of this book is $ ....

St[illegible] 18[illegible]3 -

DEPARTMENT OF EDUCATION
LELAND STANFORD JUNIOR UNIVERS

OUTLINES

OF

INDUSTRIAL DRAWING.

An Elementary Manual for the Self-Instruction
of Teachers and Pupils of Public
and Private Schools,

—BY—

PAUL A. GARIN,

Principal of Drawing in the Public Schools of Oakland, Cal.

PART I.

FIRST FOUR YEARS, OR PRIMARY WORK.

FREE HAND.

SECOND EDITION.

W. B. HARDY,
961 BROADWAY, OAKLAND, CAL.
1888.

629009
C

Copyright, 1887, by PAUL A. GARIN.

Winterburn & Co. Printers and Electrotypers, S. F.

CONTENTS.

PAGE
PREFACE 5
SUGGESTIONS 6
ABBREVIATIONS 6
GENERAL RULES (from 1 to 15 inclusive) 7

CHAPTER I.

Sections 1 to 12, inclusive.—Words: right, left, etc.—The five dots.—Rules 16 (dots) and 17 (lines).—Dictation and memory exercises.—Bisecting.—Diagrams of nine and thirteen dots 11

CHAPTER II.

Sections 13 to 24, inclusive.—Square.—Diagrams of 9, 13, 17, 21, and 25 dots.—Double or parallel lines.—Half tints.—Rules 18 (parallel lines) and 19 (half tints).—Double squares (15 dots) 22

CHAPTER III.

Sections 25 to 36, inclusive.—The inch.—Half inch diagrams.—Rule 20 (patterns).—Perpendicular lines.—Angles.—Two inch lines and spaces.—Trisecting.—Diagrams of 12, 16, 28 and 49 dots 32

CHAPTER IV.

Sections 37 to 48, inclusive.—Four inch lines and spaces.—Diagrams of 64, 100, etc. dots.—Simple curves.—Changing straight lines into curves.—Diagram of 27 dots. Oblongs of given sizes.—Natural and paper leaves 46

CHAPTER V.

Sections 49 to 64, inclusive.—The Circle.—Rule 21 (circle).—Triangles.—Quadrants.—Dividing circles into 2, 3, 4, 6, 8 and 16 equal sectors.—Regular octagon.—Regular hexagon 55

CHAPTER VI.

Sections 65 to 80, inclusive.—The Circle (continued).—Equilateral, isosceles and scalene triangles.—Diagram of 45 dots. Reversed curves.—Oblique lengths.—Tangent lines.—Symmetrical trapeziums.—Diagrams of 91 dots.—Block letters 66

CHAPTER VII.

Sections 81 to 96, inclusive.—Symmetrical divisions of squares, oblongs, circles, triangles, etc.—Compound and compound reversed curves.—Rule 22 (compound curves).—Vases.—Ellipses.—Ovals.—Spirals.—Modifying corners. Modifying long lines........................ 79

CHAPTER VIII.

Sections 97 to 112, inclusive.—Sectors.—Angles of 90, 45, 30 and 60 degrees.—Quadrilaterals.—Spirals or scrolls.—Drawing of solids by oblique projections.—Cube.—Rule 23 (cube and prisms.—Square plinth.—Square and oblong prisms.—Prismatic blocks, with faces divided into four and nine parts.. 100

PREFACE.

These "Outlines" are written with a view of helping those who have to meet the following difficulties:

1st. The limitation of time to about one hour weekly.

2d. The fulfillment of the State law requiring the teaching of "*industrial* drawing."

3d. The self-instruction of the regular teachers by whom this drawing is to be taught.

4th. The self-instruction of pupils who may use this book as a text book. The teacher thus being relieved of many explanations can keep a part of the class busy at drawing, while instructing another part in other subjects.

It is also intended as a help in manual training, and to satisfy the increasing demand of parents for such an education as shall prepare their children to learn a trade.

The aims of this book are:

1st. To train the sight.
2d. To develop the mental faculties.
3d. To enable one to master the reading and writing of the line-language of forms.

It tries to teach:

1st. Position, direction, and distance.
2d. Original designing.
3d. Industrial representation of solids.

Very little importance is attached to the *perfection of lines*, so long as the child is able to convey with them his ideas of form. In fact, a long experience has convinced me that the kind of perfection teachers often require from their classes is unnecessary and discouraging to the mass of their pupils, is attainable only by a few gifted ones, and is to all a great loss of time.

The illustrations are taken mostly from original designs made by the children themselves, and even many of the drawings for the photo-engraving of these same figures have been executed by pupils still in the grammar grades.

Numerous directions, suggestions, and corrections have been made by teachers and friends, to whom I take this opportunity of returning my sincere thanks.

These Outlines are really a revised and enlarged edition of the first half of my "Course of Study in Industrial Drawing," now entirely out of print.

P. A. G.

OAKLAND, CAL., Dec., 1887.

SUGGESTIONS.

1. Even if you are in a High or a Normal school, or if you have studied drawing already, you will make a failure of these Outlines:

(*a*) By omitting any chapter of this book.

(*b*) By not following strictly every rule.

(*c*) By spending your time in making pretty drawings instead of learning drawing.

2. In this State the law requires INDUSTRIAL DRAWING—the drawing for the use of mechanics, not artists only; the *drawing* helping manufacturers and builders; the drawing expressing the language of the useful or industrial arts, not of the polite or fine arts.

"The language of industrial and fine arts compared and contrasted:

	Industrial art should be	Fine art should be
1.	Ornamental, and not	Pictorial.
2	Conventional, and not	Natural.
3	Geometrical, and not show	Perspective.
4	Repetition	Variety.
5.	Symmetrical	Non-symmetrical."

Walter Smith.

ABBREVIATIONS USED IN THIS BOOK.

′ means *foot* or feet; ex.: 2′ reads two feet.

″ means *inch* or inches; ex.: 6″ reads six inches; 12′ 9″ reads twelve feet and nine inches.

< > means *to* or *from*; ex.: $\overset{a}{<}\overline{\;8''\;}\overset{b}{>}$ reads, from point *a* to point *b* equals eight inches.

° means *degree*; ex: 30° reads thirty degrees.

GENERAL RULES FOR FREE-HAND DRAWING.

To the Teacher.

RULE 1.

Desire perfection, but do not expect it; at least, not more than in writing, of which Industrial Drawing is an extension.

This book is neither for perfect teachers nor for artist-pupils.

"I wish to make this statement about the *unimportance* of *manual skill* in little children as emphatic as possible, because so much mischief has arisen, and harm done to education in drawing, by an overestimate of its importance. Misled by this phantom, which expects *fifty-year-old* skill in *five-year-old* bodies, and finding it not, teachers often misjudge their own excellent work, and think they have accomplished nothing. This is a serious educational mistake."—*Walter Smith.*

RULE 2.

All the **pupils** of the class should **work simultaneously.**

RULE 3.

Thirty (30) seconds should be ample time for the **distribution of drawing materials** and to get ready for the lesson.

If it takes a longer time it should not be called *drawing time.*

RULE 4.

Definitions and etymology of geometrical terms are **not required,** especially in the lower grades. A square is this, □. What is that? ▭ Ans. An oblong.

If pupils can see the difference between these two figures, and give the name of each, the teacher should be satisfied. It is not necessary to define tables, chairs, etc., to know what they are.

RULE 5.

(*a*) Encourage the pupils to make **their own designs.**

They are more interested in what they originate, than in the finest patterns drawn for them.

(*b*) Have the best of these original sketches drawn upon the blackboard.

(*c*) Select, to be copied by all, those best adapted to the capacity of the class.

(*d*) As a reward, let the pupils who have found other good patterns copy them in their own books.

(*e*) When unsuccessful in finding out a pattern as desired, let the children copy one of the same kind among those given as samples.

RULE 6.

Drawing time. *At least* one hour weekly. Divide it into half-hour lessons for large pupils, and quarter-hour and ten-minute lessons for the others.

The time passed by the teacher in talking aimlessly and in making fine and elaborate figures upon the blackboard should be subtracted from that hour. The blackboard should be used only to explain principles, to illustrate right and wrong methods of work, and to make a rough sketch of the example to be worked by the class.

RULE 7.

No great **difficulty** is found **in drawing** when the teacher:

(*a*) Studies, prepares, and practices each drawing lesson before entering the school room.

(*b*) Uses few words, and corrects carefully.

Drawing is essentially a *deed* work, not an exercise in *elocution.* The *tongue* is generally a very poor *pencil*, and the *ear* of the student should have very little to *see.*

"Never try to teach more than one thing in any one lesson."

"Be content, in criticising, to correct or call attention to one deficiency at a time, or at a lesson, leaving the others for future remarks."—*Walter Smith.*

(*c*) Never discourages his pupils, but, on the contrary, praises their efforts when he cannot commend their skill.

Be not afraid of failures; the first failure is, or ought to be, the first step towards success. Consider how we learn to walk, talk, read, write, etc. Be satisfied with little at a time, and *keep trying.*

Let us remember that free-hand drawing is only an *approximate* description of forms, and is not, like instrumental drawing, a *mathematical* representation of them. . . . "The teacher who has, at the end, nothing to show but finely drawn lines, has given poor instruction. . . . Geometrical accuracy in free-hand drawing is not expected from any one. . . . Do not, however, conclude that careless, slovenly work is ever to be tolerated, for it is not. Shun extremes."—*Walter Smith.*

IMPORTANT NOTICE.

It is not necessary to draw every example or exercise given in the lessons of this book. When a principle is well understood, or a difficulty mastered, pass on to the next. Our examples, questions, etc., are given for the benefit of those who need them on account of inexperience, want of time to study, or lack of ability to prepare their own. To the original thinker they are mere suggestions, as his own originality is better than the most servile imitation of others.

TO THE PUPIL

RULE 8.

In this course of free-hand drawing, it is **expressly forbidden:** (*a*) to erase lines; (*b*) to rule; (*c*) to measure; (*d*) to trace.

Drawing is *doing;* erasing, *undoing.* We do not learn by erasing It prevents simultaneous work by the class, cultivates carelessness, and is a loss of time. Ruling, measuring, and tracing destroy self-reliance, boldness of execution, and transform *free-hand* into *instrumental* drawing. You will be told of the exceptions to these rules in special cases, outside of which you *must* strictly adhere to the above rules if you wish to progress rapidly.

RULE 9.

(*a*) Keep your body erect.

Stand as far as possible from the slate or book. The work is better seen; the chest and sight are not injured.

(*b*) Turn your arm and body freely, not your book or slate.

This is to cause you to draw lines in all directions, and to increase the freedom of your hand.

RULE 10.

(*a*) Your **book** should always be clean, and its pages properly numbered.

(*b*) The *lower edge* of your **book** or **slate** should be parallel with that of the desk.

(*c*) Write neatly, in a small hand, upon the first page of the cover:

In the upper margin : The name of the school and number of grade.
In the left margin : The name of your teacher.
In the lower margin : Your own name and age.
In the right margin : The name of the County, and City or School District.

(*d*) Over this put an extra cover, with simply your name upon it. Do not paste or sew this extra cover to the regular one.

(*e*) Have a piece of clean paper to put under your hands. Wash them before drawing.

(*f*) Remember that your book will not be improved by curling its corners, blotting, coloring, soiling, and creasing its pages and cover.

RULE 11.

After each dot or line, your book or slate should be held vertically, at arms' length, in front of your eyes, and turned about for better examination.

This is one of the most essential directions. If it be not observed, little or no real progress can be made.

To see a line distinctly, a distance of at least from three to five times the length of that line is required.

RULE 12.

(*a*) **Pencils** should be at least four inches long; well sharpened; collected after each lesson, and used for drawing only.

(*b*) The **pencil** should be grasped lightly with the fingers, about one and one-half inches from the point. The lighter the line is to be, the farther the fingers should be placed from the point of the pencil.

(*c*) It should be held nearly at a right angle with the line being drawn.

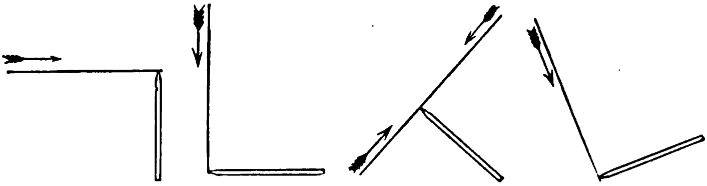


Fig. 1.

Note. Move the pencil according to the directions indicated by the arrows.

RULE 13.

(*a*) Practice often upon the **blackboard.**

Keep the center of your drawing on a **level with** and opposite your eye.

After each dot or line, stand a few feet from the board, in front of the sketch, and correct it, if necessary.

A pupil who tries to be steady by touching the blackboard with his hand or arm, will fail to acquire freedom of movement.

(*b*) When drawing very long horizontal lines, move both hand and body forward. For vertical lines, stand far enough from the board to allow the extended arm to drop easily downwards.

RULE 14.

Models :—(*a*) No surfaces, such as triangles, squares, circles ; no solids, such as cubes, prisms, pyramids, should be drawn unless each pupil has the proper model at hand.

(*b*) Always try to make your own models.

The right impression of forms should always precede the attempt to draw them.

RULE 15.

Before drawing any figure, think how it should be done, then **draw lightly, boldly,** and **rapidly.**

Rapidity is not Hurry.

"Rapid drawing may result, as it sometimes does, in the most careless and shiftless work ; but a dilatory way of working leads to a lack of interest, and this to poorly executed and unfinished exercises, and many other things which defeat the desired end, and tend to create aversion to drawing. One of the important features for which drawing is introduced in the schools is lost, for slow work with the hand will ever be against the pupil when he steps out of the schoolroom into the workshop. He who is to labor through life with his hands will gain the highest wages who uses his hands and his eyes to the best advantage."—*Walter S. Perry.*

A

CHAPTER I.

FIRST YEAR—FIRST HALF.

In this grade a lesson should rarely exceed ten minutes at a time.

Section I.

Words: **Right, Left.**[*]

1. Show, touch, point out:

(*a*) The *right* and the *left*

hands,
feet,
arms,
elbows,
shoulders,
eyes,
cheeks,
thumbs,
shoes,
sleeves, etc.

(*b*) The *right* and the *left* sides of

slates,
tables,
charts,
desks,
blackboards,
school-room, etc.

2. Point out, name what is on the *right*, on the *left* of

a desk,
a pupil,
a table,
the teacher, etc.

3. Turn, face, march to the *right*, to the *left*, in the school-room or in the yard.

Words: **Upper, Lower.**

4. Hold objects vertically, when they are not already in that position, and find out the *upper* and the *lower*:

(*a*) *Ends* of a stick, pencil, penholder, straw, etc.

(*b*) *Sides* of a chart, panel, pane of glass, slate, etc.

(*c*) *Faces*[†] of a block, box, solid.

(*d*) *Corners* of any of the foregoing or similar objects.

Do not contract any bad habit. Do not stoop, nor in any manner be too close to your work. Read rules 9, 10 (*b*), and 12.

---

[*] No apology is made for introducing drawing through language lessons. Much time is saved afterwards if *one word* can be used instead of a *whole sentence*. At any rate, drawing should not be a separate study, but a help to and a part of each of the other studies.

[†] Do not use the word "*side*," instead of "*face*" or "*surface*."

5. Place two objects (books, cubes, etc.), or draw upon the blackboard two dots, lines, etc., the one over the other; then name, touch, point out the upper, the lower one.

6. Find the

Upper left corner of a
Lower " " " "
Upper right " " "
Lower " " " "
} blackboard, wall, slate, chart, panel, page, etc.

7. Draw dots in such corners of the slate, or of the blackboard, as named by the teacher or a pupil.

8. Write the words: *right*, *left*, *upper*, *lower*.

Section 2.

Word: **Corner.**

1. Touch, point out, name:

(*a*) The corners of
(*b*) The right and left corners of
(*c*) The upper and lower corners of
(*d*) Count the number of corners of
} the school-room, the blackboard, the door, frames, charts, slates, pages, etc.

2. Write the work *corner*.

Word: **Dot.**

3. Make *light*, *small*, and *round dots* upon your slate or the blackboard.

4. Write the word *dot*.

Section 3.

Word: **Side.**

1. Draw a square or an oblong upon the blackboard, call its lines *sides*. Write the word *side* near each line.

2. Cut polygons out of paper, call their lines *sides*.

3. Tell the right, left, upper, lower *sides* of squares and oblongs.

4. Point out, touch, name the *sides* of slates, charts, boards, panels, cards, etc.

5. Draw dots along a given *side*, in a corner of the slate or board.

6. Write the word *side*.

Word: **Equal.**

7. Compare two sticks, straws, lines, etc.

Longer, shorter, *equal*.

|| are *equal* because they are of the same length; |ı are *not equal* because one line is longer than the other.

8. Fold, cut: slips of paper, sticks, straws, wooden toothpicks, and find out if they are *equal* or *not equal.*

9. Compare whole objects, like panels, desks, slates, trees, houses, boxes, etc. Find out if they are *equal,* or which is the larger, or the smaller.

10. Write the word *equal.*

Section 4.

Word: **Distance.**

1. Show the distance between two objects about the room, as: windows, doors, desks, pupils, etc., or by spreading the hands apart.

2. Put three coffee beans, beads, buttons, or the like, at equal *distances* upon the slate or desk.

3. Draw three dots upon the blackboard, and moving one of them, find out when they are at equal *distances.*

4. Draw dots at equal *distances* upon the slate.

5. Write the word *distance.*

Word: **Center.**

6. By guess, actual measurement, or diagonals, find out, show, put a finger or a dot upon the *center* of:

(*a*) A line, stick, toothpick, straw, string, etc.

(*b*) A pane of glass, page, panel, board, book cover, chart, top of a desk or table, class-room floor, walls, slate, etc.

(*c*) Of the upper, lower, right, left sides of the same objects.

7. Put a bean, button, or bead upon the *center* of the slate.

8. Draw a dot in the *center* of the slate.

Observe carefully rule 11; also rules 9, 10 (*b*), and 12.

9. Write the word *center* in the *center* of the slate or board.

Section 5.

Word: **Vertical.**

1. Tie a weight to the extremity of a string; suspend it; when motionless the string will be in a *vertical* (up and down) position.

2. Name, point out, touch:

The *vertical* lines about the room, such as are in the

walls, panels,
windows, blackboards,
doors, charts, etc.

3. Hold up books, slates, pencils, pens, pointers, arms, etc., in a *vertical* position.

4. Draw *vertical* lines upon the slate and blackboard.

5. Put a button or bead in the *center* of the slate, and other beads at *equal distances* above and below, in a *vertical* row. Make other *vertical* rows on each side of the first.

6. Repeat this with dots instead of beads.

7. Write the word *vertical.*

Read and observe rules 9, 10, 11 and 12

Section 6.

Word: **Horizontal.**

1. Have a straw or a stick floating in a glass, or in a pail of water.

2. Find out lines in that same position, like lines in the floor, upper and lower sides of walls, blackboards, charts, doors, windows, panels, panes, tables, desks, benches, etc.

3. Name *horizontal* surfaces, as floors, ceilings, tops of tables etc.

4. Draw *horizontal* lines upon the blackboard or slate.

5. Put a bead in the center of slate and others at equal distances to the left to the right of it and in a *horizontal* row. Make other *horizontal* rows with beads, beans, grains of wheat, etc., at other places on the slate or desk.

6. Repeat the last exercise with dots instead of beads.

7. Write the word *horizontal.*

Word: **Margin.**

8. Open a book and show the *margins.*

9. Point out, touch the *margins* on engravings, charts, cards, maps, etc.

10. Write the word *margin.*

11. Remember to leave a *margin* between your dots or lines and the edge of your slate.

Read and observe rules 9, 10, 11, and 12.

Section 7.

RULE 16.

(*a*) Make **dots** *light*, *small*, and *round.*

(*b*) When numbered in this book, make them in the order of the numerals.

(*c*) Never number dots on slates or in blank books.

The numerals distract the eye from the proper spacing of the dots.

(*d*) When dots are not numbered in this book they should be drawn, as far as possible, in the following order: (1) center, (2) left, (3) right, (4) above, and (5) below the center.

THE FIVE DOTS.

Read and observe rules 9, 10, 11, 12, and 13.

.4
.2 .1 .3
.5
Fig. 2.

(*a*) Draw dot 1 in the center of your slate.

HOLD UP YOUR SLATE. See rule 11.

Correct, if necessary.

(*b*) Draw dot 2 to the left, horizontally with center. Leave a margin of about ½ inch (the width of your first finger) on the left side of your slate.

HOLD UP YOUR SLATE.

Should you draw dot 3 before dot 2, your hand would obstruct your sight in spacing off the left dot.

(*c*) Draw dot 3 to the right, horizontally with center, and at the same distance from center as dot 2.

HOLD UP YOUR SLATE.

(*d*) Draw dot 4 vertically above center, and at the same distance from it as dots 2 and 3.

HOLD UP YOUR SLATE.

NOTE.—This dot 4 is naturally placed too near the center. If you take two rulers, each one foot long, and hold one ruler vertically, while the other is placed horizontally, the vertical ruler will appear somewhat longer than the horizontal one. On account of this illusion of the eye, if we try to draw two equal lines, one vertically, and the other horizontally, we are inclined to make either the *vertical line too short* or the *horizontal line too long.*

Remedy: Turn your slate about in front of your eye, so that each side of the slate shall be in turn the lower side. See rule 11.

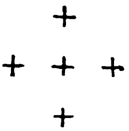
An opposite mistake is often made: pupils will draw dots 4 and 5 too near the upper and the lower edges of oblong slates, instead of having these dots at *equal distances* from the *center.* This is caused by the pupils thinking they must have an equal margin all around the slate.

(*e*) Draw dot 5 vertically below center dot 1, and at the same distance from it as dots 2, 3 and 4.

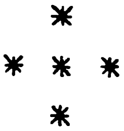
HOLD UP YOUR SLATE.

Examine and see that your dots make straight vertical and horizontal rows.

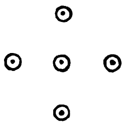
In the same manner, draw:



3.
5 crosses.



4.
5 stars.



5.
5 rings.

Section 8.

RULE 17.

To draw a **line**.

(*a*) Make a *dot* for *each end* of the line.

(*b*) Without touching the slate or paper, carry the pencil three times over the path of the intended line.

(*c*) *Sketch the line very lightly, looking at the dot it is desired to reach, and not at the point of the pencil.*

"When a carpenter drives a nail, he does not look at his hammer, but at the nail-head. Just so in drawing a line to hit a given dot, look at the dot and not at the pencil. All beginners are inclined to do the opposite; the teacher, therefore, must give especial attention to this matter."—*Charles B. Stetson.*

(*d*) If the *sketch* be *wrong*, correct it by drawing another light line.

(*e*) **Line in** with a slow, uniform motion, following the corrected sketch.

Never allow the pencil to move faster than the eye or mind; otherwise, the line will be drawn at hazard.

See that the hand does not obstruct the vision.

(*f*) Make the line of the same apparent width throughout its whole length.

(*g*) Make it *gray* rather than white upon slates, or black upon paper.

(*h*) Use the arm or shoulder movement.

Read and observe carefully rules 8, 9, 10 (*b*), 11, 12, 13, and 15. Also, rule 16, § 6, and rule 17, § 8.

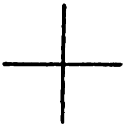


Fig. 6—A cross.

1. Draw the five dots, fig. 2, p 15.

2. Draw an horizontal line from dot 2 to dot 3.

Apply rule 17, viz:

(*a*) Put your pencil on 2, look at 3.

(*b*) Without looking at the point of your pencil, and without touching your slate with it, move it steadily from 2 to 3.

(*c*) Repeat this three or four times.

(*d*) The last time, draw as light a line as possible.

HOLD UP YOUR SLATE. DO NOT ERASE.

If wrong, next time you will be more careful. You will think before moving, and observe rule 17.

3. In the same manner draw a vertical line from dot 4 to dot 5.

HOLD UP YOUR SLATE. DO NOT ERASE.

4. Repeat this exercise upon the blackboard, observing rule 13.

If you cannot help looking at the point of your pencil or crayon, place a book or a large card between your pencil and your sight.

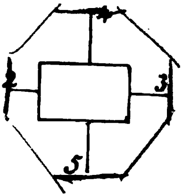


Fig. 7.

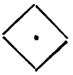
Section 9.

SQUARE—OBLIQUE LINES.

Models. Each pupil should have a 4 inch square with a dot in its center.

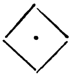
1. Write the word *square.*

2. Talk about the *square;* touch, examine, compare, name its corners, sides, center, etc.

3. Hold it vertically upon one of its angles,  call its lines in that position *oblique* lines or sides.

4. Find other *oblique* lines in the room, like the slanting sides of desk-tops, picture frames, etc.

5. Hold up in vertical, horizontal, and *oblique* positions objects such as pencils, penholders, sticks, straws, toothpicks, arms, pointers, etc.

6. Finally, put the square thus  upon the desk.

Its corners are like dots 2, 3, 4, and 5 at the same distance from its center.

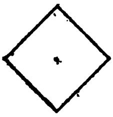
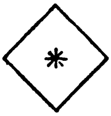
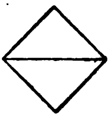


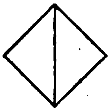
Fig. 8.



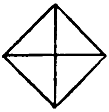
9.



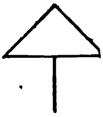
10.



11.



12.



13.

(*a*) Draw the five dots, p. 15.

(*b*) Turn your body slightly to the right; do not turn your slate. Draw an oblique line from dot 4 to dot 2, observing rule 17, p. 17.

HOLD UP YOUR SLATE. DO NOT ERASE.

(*c*) In the same manner draw line from 3 to 5.

HOLD UP YOUR SLATE. DO NOT ERASE.

(*d*) Turn slightly to the left. Do not turn your slate. Draw line from 2 to 5.

HOLD UP YOUR SLATE. DO NOT ERASE.

(*e*) Draw line from 4 to 3.

HOLD UP YOUR SLATE. DO NOT ERASE.

Place your paper square, and your slate in the same vertical position in front of your eye.

Does your drawing look like the square? If not, which dot is too near or too far from the center?

Work fig. 9, 10, 11, 12, and 13 in the same manner.

Section 10.

DICTATION AND MEMORY EXERCISES.

.4
.2 .1 .3
.5
Fig. 14.

(*a*) Draw the five dots with their numerals (fig. 14) upon the blackboard. (*b*) Each pupil draws the same dots without the numerals upon his slate, as in Sec. 7.

DICTATION.

(*a*) Put the point of your pencil upon dot 1, dot 2, dot 3, dot 4, dot 5, dot 3, dot 2, etc.

(*b*) Put your pencil upon dot 2, dot 3, dot 2, dot 3, 2, 3, draw a line from 2 to 3.

Hold up your slate and examine. Do not erase.

(*c*) Put your pencil upon dot 4, dot 5, 4, 5, 4, 5, 4, draw a line to 5.

Hold up your slate; examine. Do not erase.

(*d*) Turn your body slightly to the right, put your pencil upon 4, 2, 4, 2, 4, 2, 4, draw a line to dot 2.

Hold up your slate.

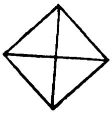
(*e*) Pencil upon 3, 5, 3, 5, 3, 5, 3, draw to 5.

Hold up your slate. Do not erase.

(*f*) Turn your body slightly to the left; pencil upon 2, 5, 2, 5, 2, 5, 2, draw to 5.

(*g*) Pencil upon 4, 3, 4, 3, 4, 3, 4, draw to 3.

Hold up your slate. Do not erase.

Now, draw  upon the blackboard. Pupils compare.

Any other figure may be dictated in the same manner.

MEMORY EXERCISES.

1st. Draw any one of the figures, from fig. 8 to fig. 13, you like best. Remember everything you had to do—the order and manner in which you did it. Do not omit anything: positions, holding up slate, drawing light lines, etc.

2d. In the same manner, draw from memory any example called for by the teacher.

3d. The teacher draws a new five-dot figure upon the blackboard, explaining slowly what to do. When finished the figure is covered up and the pupils draw it from memory, without further explanations. At the end of the exercise the figure is uncovered, and the pupils compare their work with that on the blackboard.

Section II.

BISECTING—THE NINE DOTS.

Bisect. 1st. Cut, tear, break into halves: a stick, a string, a straw, a slip of paper, etc.

2d. Draw an horizontal line on the blackboard or slate. Placing your finger over its center, *bisect* the line (erase across it). Same with vertical and oblique lines.

3d. Draw the same lines again, and *bisect* them by putting a dot upon the center of each.

The nine dots.

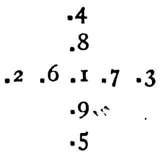


Fig. 15.

(*a*) Draw center dot 1. Hold up your slate.

(*b*) Draw left dot 2. Hold up your slate.

(*c*) Draw right dot 3. Hold up your slate.

(*d*) Draw upper dot 4. Hold up your slate.

(*e*) Draw lower dot 5. Hold up your slate.

(*f*) Bisect distance between dots 1 and 2, (dot 6). Hold up your slate.

(*g*) Bisect distance between dots 1 and 3, (dot 7). Hold up your slate.

(*h*) Bisect distance between dots 1 and 4, (dot 8). Hold up your slate.

(*i*) Bisect distance between dots 1 and 5, (dot 9). Hold up your slate.

NOTE.—Little by little you should form the habit of holding your slate, pencil, hand, and body in correct positions, and of examining your work at arms' length and correcting it when wrong, all this WITHOUT BEING TOLD EACH TIME.

To the teacher. Different methods of drawing the following examples:

1. The teacher explains and draws one dot or line at a time upon the blackboard, the pupils draw the corresponding dot or line upon their slates.

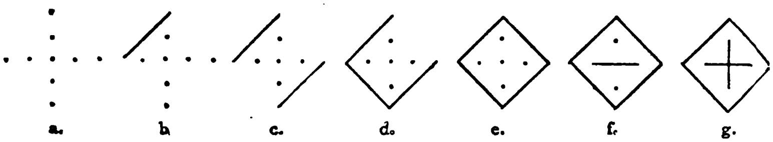


Fig. 16.

2. The teacher explains and draws the whole figure at once upon the blackboard, the pupils listen and question, then themselves draw the whole figure without further help from the teacher. For instance, the teacher goes through the seven stages of fig. 16, and when the example is finished the pupils draw it step by step, as they have been told.

3. Dictating as in section 10. The teacher numbers dots (as in fig. 15) upon the blackboard. The pupils draw the nine dots without the numerals.

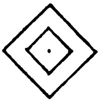
Dictation: (*a*) Put your pencils upon dot 4, upon 2, 4, 2, 4, 2, 4, draw a line to dot 2.

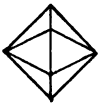
(*b*) Pencil upon 3, 5, 3, 5, 3, 5, 3, draw to 5.
(*c*) " " 2, 5, 2, 5, 2, 5, 2, draw.
(*d*) " " 4, 3, 4, 3, 4, 3, 4, draw.
(*e*) " " 6, 7, 6, 7, 6, 7, 6, draw.
(*f*) " " 8, 9, 8, 9, 8, 9, 8, draw.
Lay your pencils upon the desks.

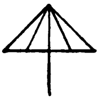
Then the figure is drawn upon the blackboard, and the slates are examined and marked.

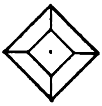
4. Draw upon the blackboard the whole fig. 16 without any explanation. The pupils find out their own methods. The teacher corrects the wrong ones.

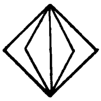
Other examples upon the nine dots.

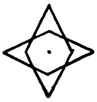

17.

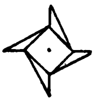

18.


19.


20.


21.


22.


23.

Once in a while, for variety:

1st. Space dots, using beans, beads, etc.

2d. Make foregoing figures with wooden toothpicks, or narrow slips of white or colored paper.

3d. Draw the same upon the blackboard, using colored crayons.

4th. Use paper and lead pencils.

Do not forget to place a 4-inch square obliquely before you, upon your desk; the nine dots may be marked upon one of the faces of the square.

For memory lessons, see section 10.

Section 12.

THE THIRTEEN DOTS.

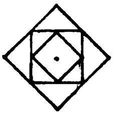
.4
.10.8 .12
.2 .6 .1 .7 .3
.11.9 .13
.5

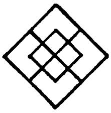
Fig. 24.

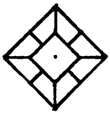
(*a*) Draw the nine dots (fig. 15).
(*b*) Bisect distance 4–2. Hold your slate up.
(*c*) Bisect distance 2–5. Hold your slate up.
(*d*) Bisect distance 4–3. Hold your slate up.
(*e*) Bisect distance 3–5. Hold your slate up.

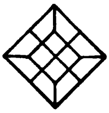
Let the dots be in *straight* rows, vertically, horizontally, and obliquely.

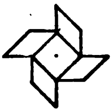
Alternating the methods explained on page 19, draw the following or similar examples:

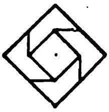

25.

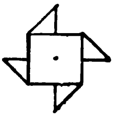

26.

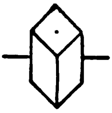

27.

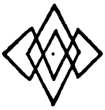

28.

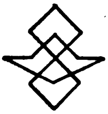

29.

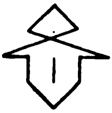

30.

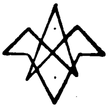

31.

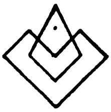

32.

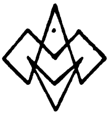

33.

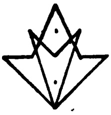

34.

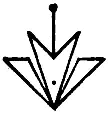

35.

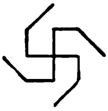

36.

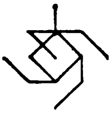

37.


38.


39.


40.


41.


42.

For memory exercises, see section 10.

CHAPTER II.

FIRST YEAR—SECOND HALF.

To the Teacher.—As a reward, pupils may be allowed to draw on paper with lead pencils.

In lower grades: "Inventive drawing, to be recreation or amusement, and pursued as in Kindergarten Schools. Children unable to do it to be allowed to rest and watch those who can, and never to be distressed by their work."—*Walter Smith.*

Section 13.

NINE DOTS FOR AN UPRIGHT SQUARE.

Remember rule 11, and to hold your hand and body, slate and pencil in proper positions, **without being told each time.**

Each pupil should have a 4-inch card-board square, and large one-foot squares should be hung upon the walls of the school-room in these two positions— □ and ◇

.6 .4 .8
.2 .1 .3
.7 .5 .9
Fig. 43.

or

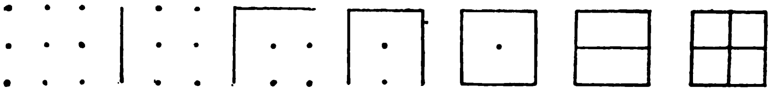
.6 . .7
. . .
.8 . .9
Fig. 44.

(*a*) Draw the five dots. (fig. 2, sec. 6.)

(*b*) Add dots 6, 7, 8 and 9.

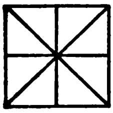
Be careful to have all these dots in vertical and horizontal rows.

By one of the methods explained in section 10, draw:

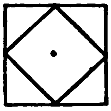


a. b. c. d. e. f. 45.

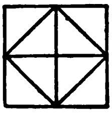
Other samples:



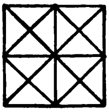
46.



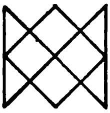
47.



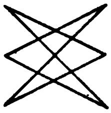
48.



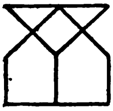
49.



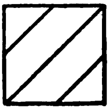
50.



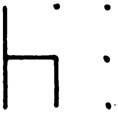
51.



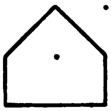
52



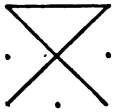
53.



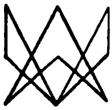
54.
A chair.



55.
House.



56.
Folding Table.



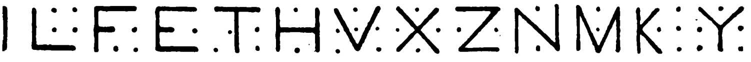
57.

Try to invent your own patterns.

Let all your lines *begin* and *end* at the *dots*. *Do not draw curves.*

When inventing your own patterns you may erase the lines you dislike, and replace them by others. This is an exceptional case. You must not erase in any other.

How many capital letters can you make with these nine dots? Ans. 13.



58.

Section 14.

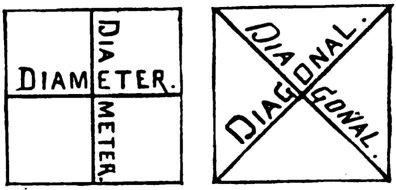
THIRTEEN DOTS—UPRIGHT SQUARE.

Read and observe former rules.

Handle, talk about the square, its diameters, its diagonals.

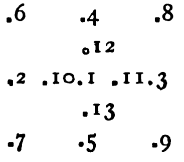
Draw the nine dots, then fig. 59.

Write or print the words *diameter* and *diagonal* close to the proper lines.



59.

Leave these sketches upon the blackboard.



60.

(*a*) Draw fig. 43.

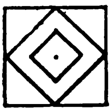
(*b*) Bisect with the dots 10, 11, 12 and 13.

Invent your own pattern.

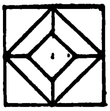
Remember the rule:

Each line must begin upon one and end upon another of these thirteen dots. No curves.

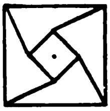
Using one of the methods of p. 19, any of the following figures may be drawn.



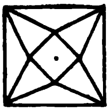
61.



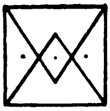
62.



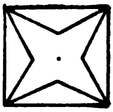
63.



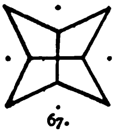
64.



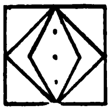
65.



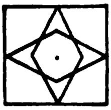
66.



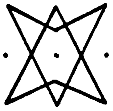
67.



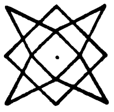
68.



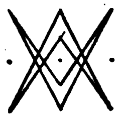
69.



70.



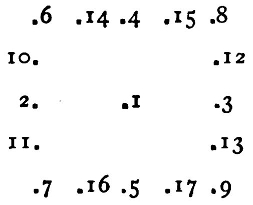
71.



72.

Section 15.

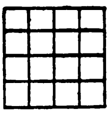
A DIAGRAM WITH 17 DOTS.



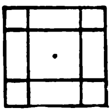
73.

Draw dots as numbered.
Invent your own patterns.
Read rule 5.

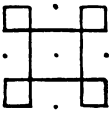
Samples of work to be done.



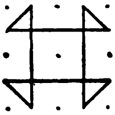
74.



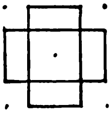
75.



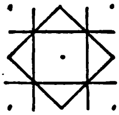
76.



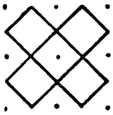
77.



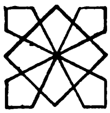
78.



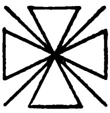
79.



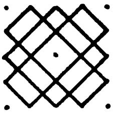
80.



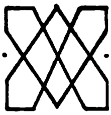
81.



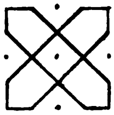
82.



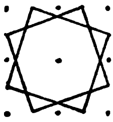
83.



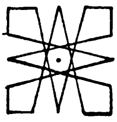
84.



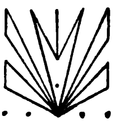
85.



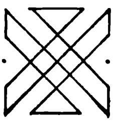
86.



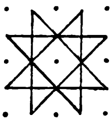
87.



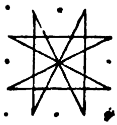
88.



89.



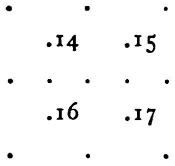
90.



91.

Section 16.

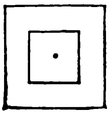
ANOTHER DIAGRAM WITH 17 DOTS.



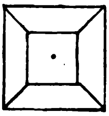
92.

(*a*) Draw fig. 60.
(*b*) Add dots 14, 15, 16 and 17.
Follow former rules.
Remember the dictation and memory exercises.
Invent your own patterns, and draw the best ones upon the blackboard.

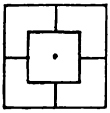
Samples.



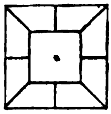
93.



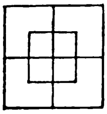
94.



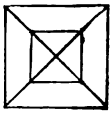
95.



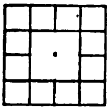
96.

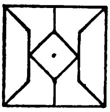


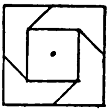
97.

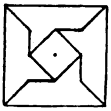


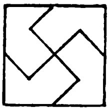
98.

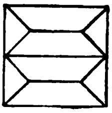

99.

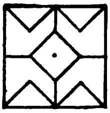

100.

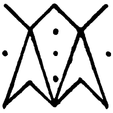

101.

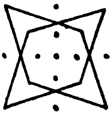

102.

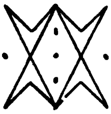

103.

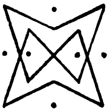

104.

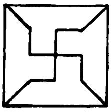

105


106.


107.


108.


109.


110.

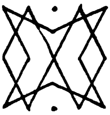
Section 17.

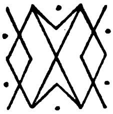
. . . . . .
. .20 .
. .18. .19.
. .21 .
. . . . . .

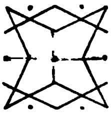
111.

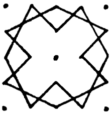
(a) Draw fig. 73.
(b) Add dots 18, 19, 20 and 21.
Follow closely former rules.
Invent your own designs.

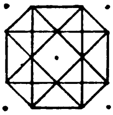
Samples.

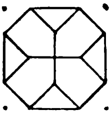

112.

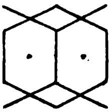

113.

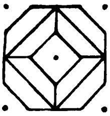

114.

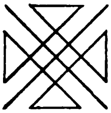

115.

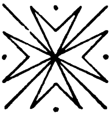

117.

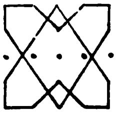

118.

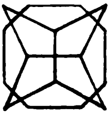

119.


120.


121.


122.


123.


124.

Section 18.

TWENTY-FIVE DOTS.

Do not draw dots always in the same order.

.6 .18.4 .19.8
.14.22.12.24.16
.2 .10.1 .11.3
.15.23.13.25.17
.7 .20.5 .21.9

125.

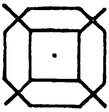
ex: 6 10 4 11 7
16 18 20 22 24
2 12 1 13 3
17 19 21 23 25
8 14 5 15 9

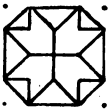
1 2 3 4 5
6 7 8 9 10
11 12 13 14 15
16 17 18 19 20
21 22 23 24 25

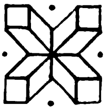
and other variations.

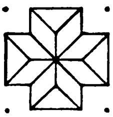
Work as in preceding sections.

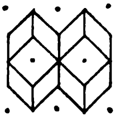
Samples:

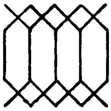

126.

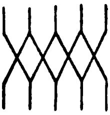

127.

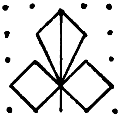

128.

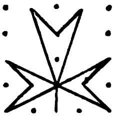

129.

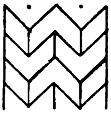

130.

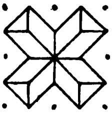

131.

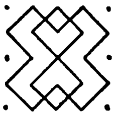

132.

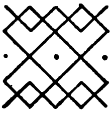

133.

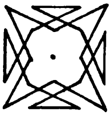

134.

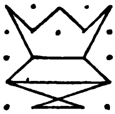

135.

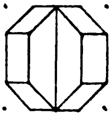

136.

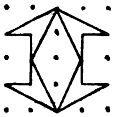

137.

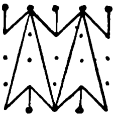

138.

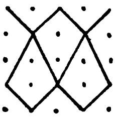

139.

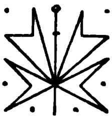

140.

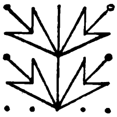

141.


142.


143.


144.

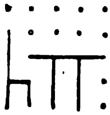

145.

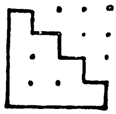

146.

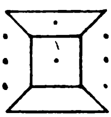
Section 19.

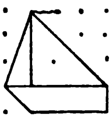
PICTURES.

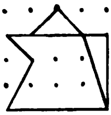
No picture should be drawn unless the twenty-five dots are correctly spaced. This exercise is not for fun, but as a reward for accurate work. Samples:

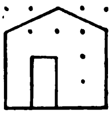

147.

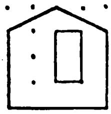

148.

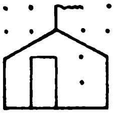

149.

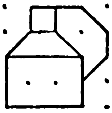

150.

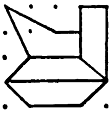

151.

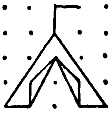

152.

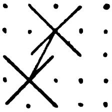

153.

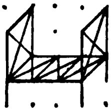

154.

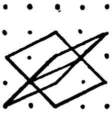

155.


156.


157.


158.


159.


160.

Section 20.

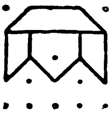
BLOCKS.

Here, again, space your twenty-five dots carefully, or the value of this exercise will be lost.

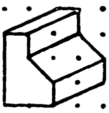
After the drawing of a block, turn your slate about, so as to have successively each side of it as a lower side. Find out and tell what each block is good for.

Try to make other blocks out of these twenty-five dots.

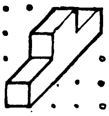
Samples :



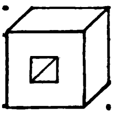
161.



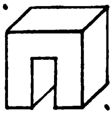
162.



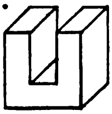
163.



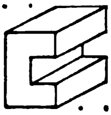
164.



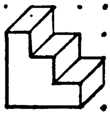
165.



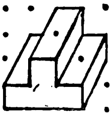
166.



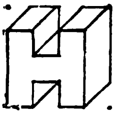
167.



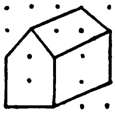
168.



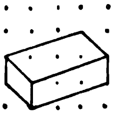
169.



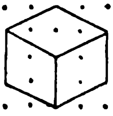
170.



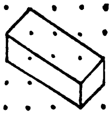
171.



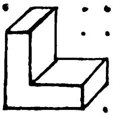
172.



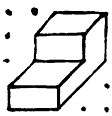
173.



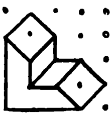
174.



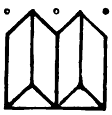
175.



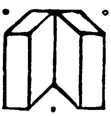
176.



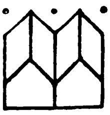
177.



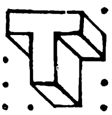
178.



179.



180.



181.

Section 21.

PARALLEL (OR DOUBLE) LINES.

1st. Make **parallel** lines with toothpicks, sticks, pointers, penholders, pencils, etc.

2d. Point out, show, when these same objects are not *parallel.*

3d. Show, name, touch the *parallel* lines :

(*a*) In doors, windows, frames, blackboards, books, charts, slates, sheets of paper, panels, desks, tables, floor joints, etc.

(*b*) In sides of cubes, square and oblong boxes, walls.

(*c*) In rows of desks, trees, etc.

RULE 18.

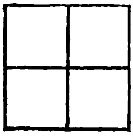
(*a*) To draw a line *parallel* to another, keep constantly in sight the first line drawn.

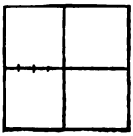
(*b*) Do not make dots for the extremities of close *parallel* lines, but draw them very lightly at once.

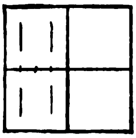
(*c*) Make the space between the two lines neither too wide nor too narrow.

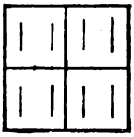
(*d*) All the spaces of the same figures should be alike.

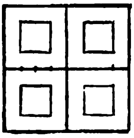
Draw:


a.

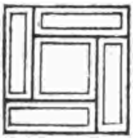

b.

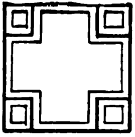

c.

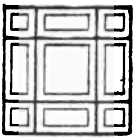

d.

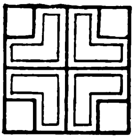

182.

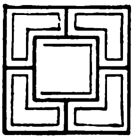
Other samples:

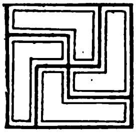

183.

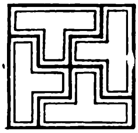

184.

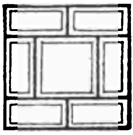

185.

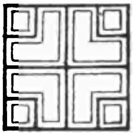

186.


187.


188.


189.


190.

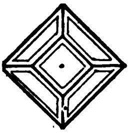

191.

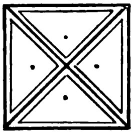
Section 22.

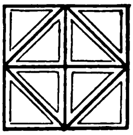
Select any other simple combination from the preceding diagrams and draw lines parallel to the lines of those patterns.

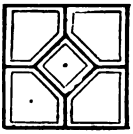
You may surround the whole pattern with parallel lines.

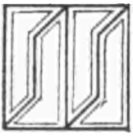
Samples from figures 20, 47, 59, etc.

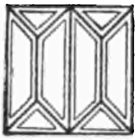

192.


193.

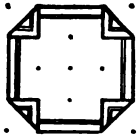

194.


195.

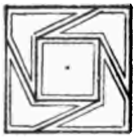

196.



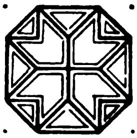
197.



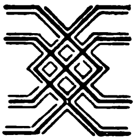
198.



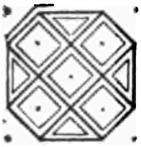
199.



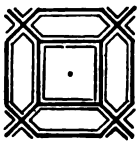
200.



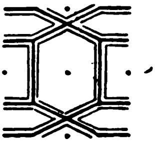
201.



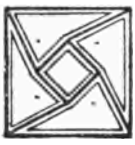
202.



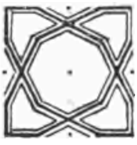
203.



204.

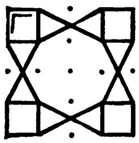


205.

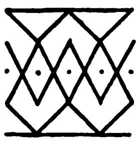


206.

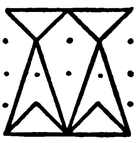
Add parallel lines to the following:



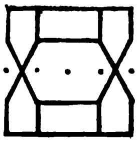
207.



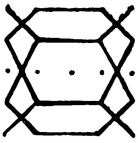
208.



209.



210.



211.

Find others.

Section 23.

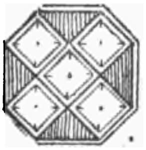
RULE 19.

Half tints:—(*a*) Let the space between your lines be about the apparent width of these same lines, thus: ||||.

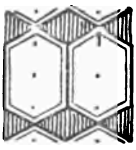
(*b*) Do not tint more than one-half of the space covered by your design.

Use colored crayons, if possible.

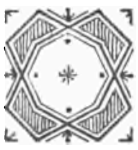
Samples:



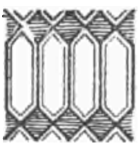
212.



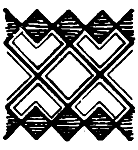
213.



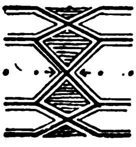
214.



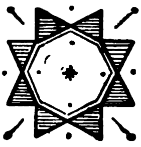
215.



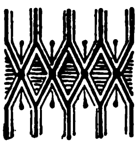
216.



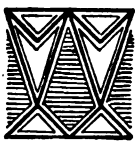
217.



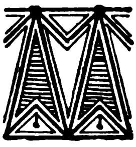
218.



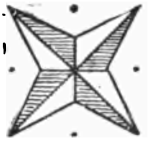
219.

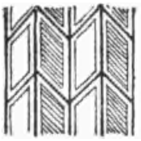


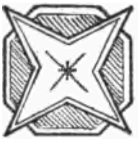
220.

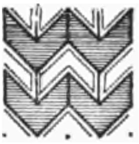


221.


222.


223.


224.


225.

Find others.

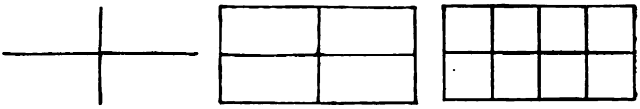
Section 24.

DOUBLE SQUARES (OBLONGS).

.6	.8	.10	.12	.14		6	7	8	9	10		1	2	3	4	5
.2	.4	.1	.5	.3	or	2	4	1	5	3	or	6	7	8	9	10
.7	.9	.11	.13	.15		11	12	13	14	15		11	12	13	14	15

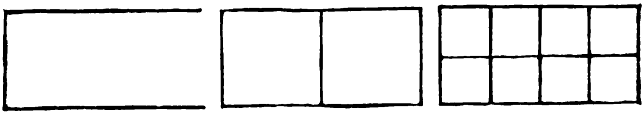
226.

Dots being for beginners, it is well to learn gradually how to draw *light* lines without dots, in order to work more rapidly and even more accurately.

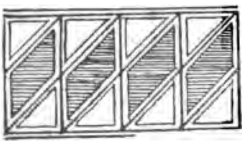

a. b. c.

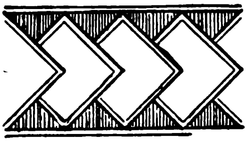
227.

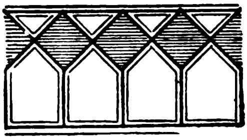
Or,

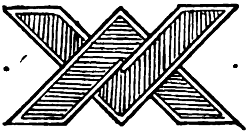

228.

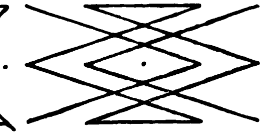
Invent new patterns, or copy the following. Use colored crayons.
Samples:

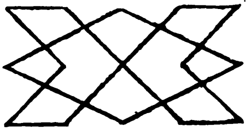

229.

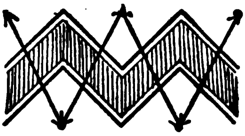

230.


231.

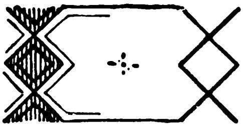

232.


233.

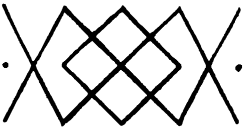

234.



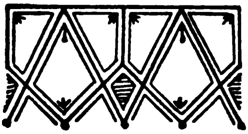
235.



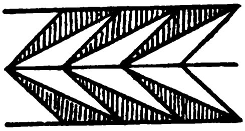
236.



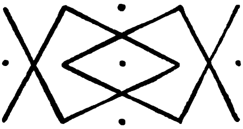
237.



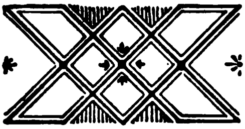
238.



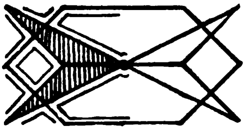
239.



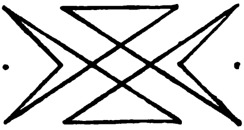
240.



241.



242.



243.

You may finish the figures that are not completed.

CHAPTER III.

SECOND YEAR—FIRST HALF.

1. Whenever possible, use a lead pencil and paper. A book is easily made with common wrapping manilla paper. Size of pages, about 6x8 inches.

2. Treat drawing as you do penmanship: *do not erase.* If any figure be wrong, try anew. This saves time, and cultivates care, attention, neatness, and precision..

3. To make your hand really *free*—
   (*a*) Use the shoulder movement.
   (*b*) Draw lightly, boldly, rapidly.
   (*c*) Practice often upon the blackboard.

4. Observe carefully all former rules.

Section 25.

THE INCH.

1. Handle, examine, your paper inch-square. Tell about its corners, sides, center, base, diameters, and diagonals.

2. With the sides of that square, **rule** lines in these positions— |, —, \, /. Make each line exactly the length of one of the sides of your paper square. Try to remember **how long** inch lines are.

3. Put your square upon your desk in front of you. Without spacing dots or using the square, draw an horizontal **inch** line, then **measure** it with your square.

Caution.—Your line must be exactly *one* inch long. When too short, put a dot where the end of the line should have reached (——•). When too long, draw a short line where the inch line should have ended (——+).

Try several times. In the same manner draw |, \, and / lines.

4. Repeat last exercise with └ ┐┌ ┘. Measure and correct. How many lines are exactly *one* inch long?

5. A better way of correcting is to exchange slates with another pupil. Find out and write the number of *perfect* lines your schoolmate has drawn.

6. Put your paper square out of sight. Draw the preceding exercises from memory. Exchange, measure, correct slates as directed in last paragraph.

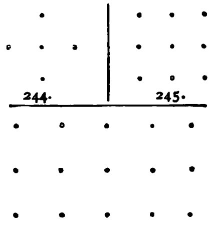
To the Teacher.—In *examinations*, mark as perfect a line either $\frac{1}{16}$ shorter or

$\frac{1}{16}$ longer than its true length should be. For instance, a line from $\frac{15}{16}$ to $\frac{17}{16}$ of an inch in length is reckoned as one inch.

Double the allowance for 2 inches, triple for three inches, etc.

7. In the same manner draw : ⊏ ⊐ ⊓ ⊔ and □. Each line equals 1 inch (1").

8. On paper (or slate),



244. 245. 246.

Divide page as shown here.

Draw diagrams 244, 245, 246, placing the dots **one inch** apart.

Draw patterns as in sections 9, 13, and 24.

Do not use curves.

Could you cut a *one inch paper square?*

Section 26.

1. Handle, examine, talk about the inch-square.

Put it in front of you. *Look at it* during the lesson, but *do not use it* for spacing dots.

Caution. Hereafter, **you are forbidden to measure your own work.** Change slate or paper with your neighbor, and correct **his** lines.

To the teacher. Observe direction 5, page 7.

A four-inch card-board square may be used by the teacher, or by a few monitors in correcting the work of the class.

2. On slate or paper :

Draw, in the following order, 25 dots, one inch vertically and horizontally from each other. Make a design (see sec. 18). Add parallel lines or half tints. No curves.

10		7		12
		6		
3	2	1	4	5
		8		
11		9		13

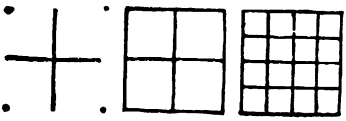
a.

10	14	7	15	12
16	17	6	18	19
3	2	1	4	5
20	21	8	22	23
11	24	9	25	13

b.

247.

A shorter method of drawing diagram 247 would be, after spacing dots 1 to 13 inclusive, to draw very fine and light lines (fig. 248).



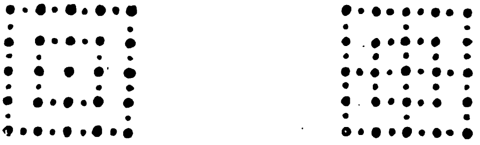
a. b.

248.

The advantages resulting from this practice are: a saving of time, a more accurate diagram, a freer handling of pencil, and a habit of drawing light and bold lines.

Section 27.

HALF INCH SPACES.



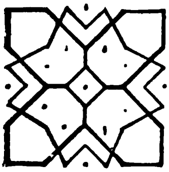
a. 249. b.

(*a*) Draw 25 dots as in fig. 247.
(*b*) Bisect inch spaces as shown in fig. 249.
Make a pattern.

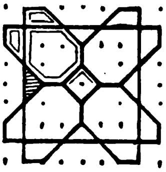
RULE 20.

Patterns. (*a*) Space *correctly* the dots or lines of the diagram.
(*b*) Draw the outer lines (outlines) of the pattern first.
(*c*) Make the opposite corners alike.
(*d*) Make the opposite sides alike.
(*e*) Divide the inside of the figure into a few parts alike.
(*f*) Avoid passing through the center of the diagram.
(*g*) *Do not draw too many lines.*
(*h*) Do not use curves.
(*i*) Prepare your pattern upon your slate or the blackboard, so as to be able to *rub out* easily the lines you do not fancy; but in copying your design **upon paper, do not erase.**
(*k*) Draw parallel lines or half tints, when possible.
(*l*) Use colored crayons, when possible.

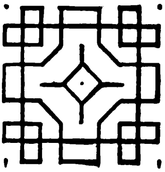
Samples:



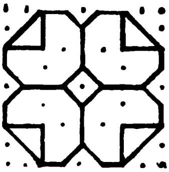
250.



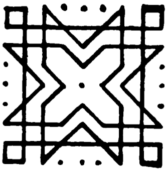
251.



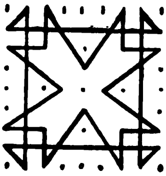
252.



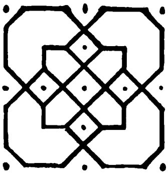
253.



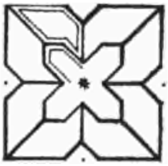
254.



255.

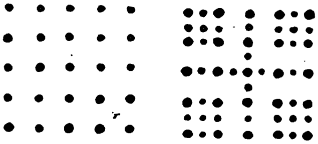


256.



257.

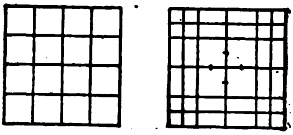
Section 28.



(a) (b)

253.

or



(a) (b)

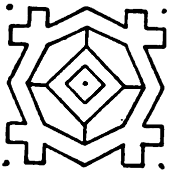
259.

Draw *very light* lines.

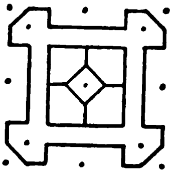
Make a pattern upon this diagram.

Observe rule 20, section 27.

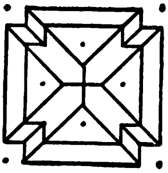
Samples:



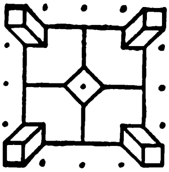
260.



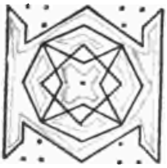
261.



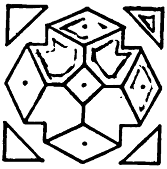
262.



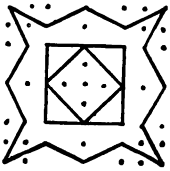
263.



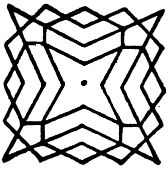
264.



265.



266.



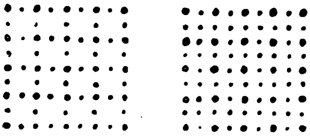
267.

Section 29.

Work as in preceding sections.

(a)

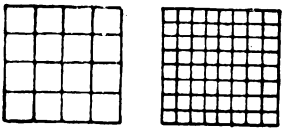
Draw
the 25
dots
fig. 247.



(b) (c)

268.

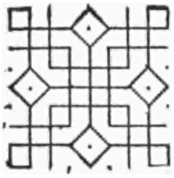
or



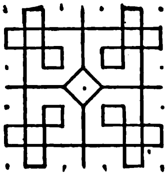
(b) (c)

269.

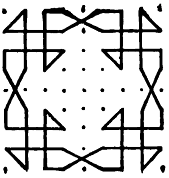
Samples:



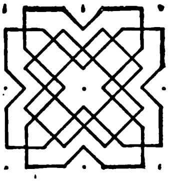
270.



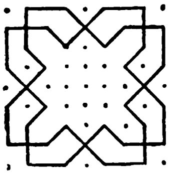
271.



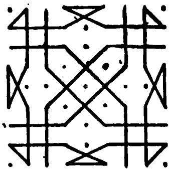
272.



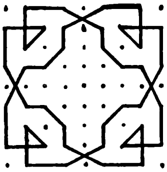
273.



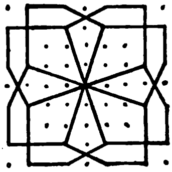
274.



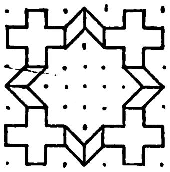
275.



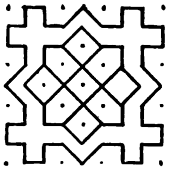
276.



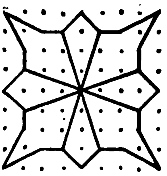
277.



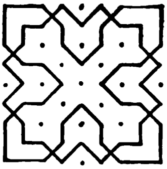
278.



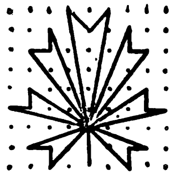
279.



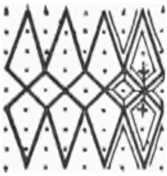
280.



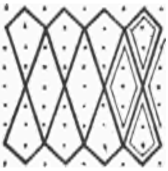
281.



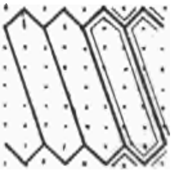
282.



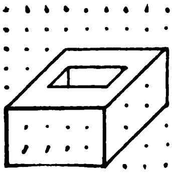
283.



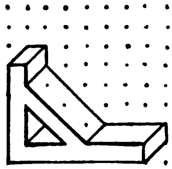
284.



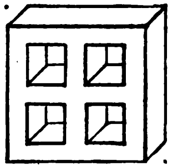
285.



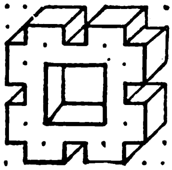
286.



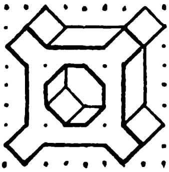
287.



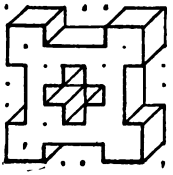
288.



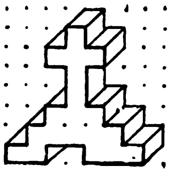
289



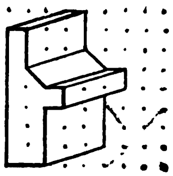
290.



291.



292.

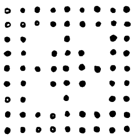


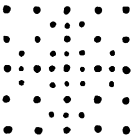
293.

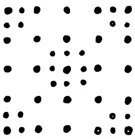
Section 30.

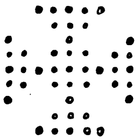
SUBTRACTING DOTS.

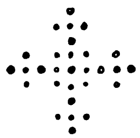
By omitting some of the dots of fig. 268, other diagrams may be obtained.


294.

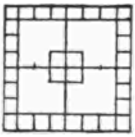

295.

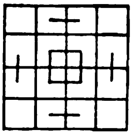

296.

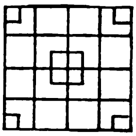

297.

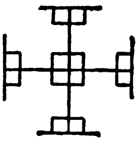

298.

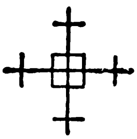
or


299.


300.

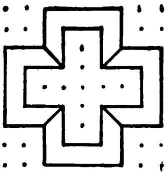

301.

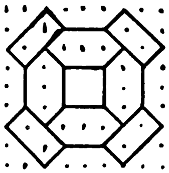

302.

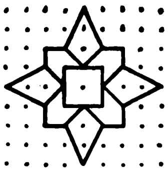

303.

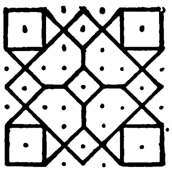
Work as in preceding sections.

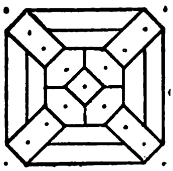
Samples:

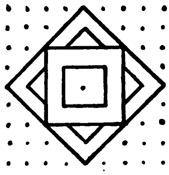

304.

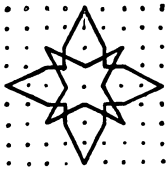

305.

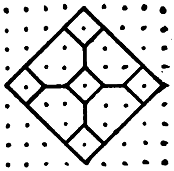

306.

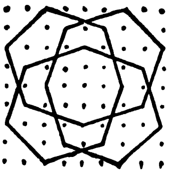

307.

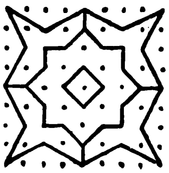

308.

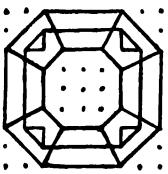

309.

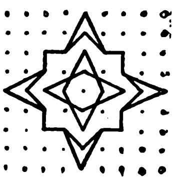

310.

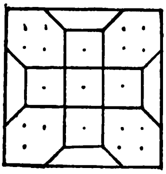

311.

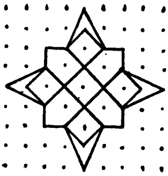

312.

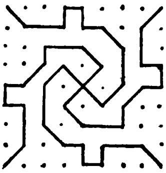

313.

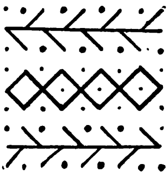

314.


315.


316.


317.


318.


319.

Most of these patterns were made by children.

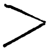
Section 31.

PERPENDICULAR LINES—ANGLES.

1. Draw these two lines : ══. These lines are **parallel** because they run in the **same direction.**

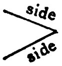
An **angle** is the **difference of direction** of two lines that meet in a point, or would meet if sufficiently extended.

Draw these two lines :



Are these lines parallel? Why? What do you call two lines running in **different directions**?

Draw and write: *Angle*

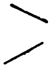


Vertex

320.

What is the **vertex** of an *angle*?

Is this



an *angle*? Why?

2. Make *angles* with sticks, pencils, penholders, etc.

3. Find lines making *angles* in doors, windows, walls, tables, desks, charts, books, boards, etc.

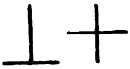
Do you know two streets or roads making an *angle* or *angles*?

How many *angles* in a square?

With only two sticks or pencils, can you make one angle?—two?—three?—four?—five angles?

4. A **perpendicular** line is a line making **equal angles** with another line.

Example :

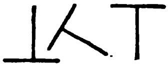


321.

Upon your desk, make *perpendicular* lines with sticks, pencils, etc.

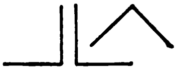
Point out lines *perpendicular* to others in this room.

Can you draw *perpendicular* lines in eight different positions?

Example:  Find the others.

322.

5. One of the **equal** angles made by perpendicular lines is called a **right angle.**



323.

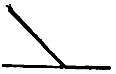
Find *right angles* about this room.

Look at slates, charts, tables, books, walls, doors, etc.

Turn a paper-square in different positions; remember the *look* of its angles.

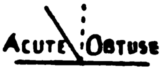
Can you draw eight right angles, each in a different position?

Caution. Be sure that each angle *looks* like one of the corners of your paper-square.

6. Draw . Tell why these lines should not be called

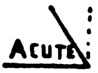
324.

perpendicular lines.

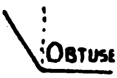
Draw and write 

325.

Draw each angle by itself.



326.

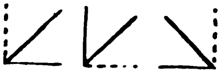


327.

One angle is *greater* and the other *smaller* than a right angle.

What is the name of an angle smaller than a right angle?—greater than a right angle?

Change these right angles into acute angles: └ └ ┘ ┘ ┌ ┌ ┐ ┐

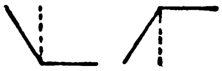
Example: 

328.

Draw: | | | | — — — — / / / /. With these lines make 12 acute angles, each in a different position.

Change into obtuse angles: └ └ ┐ ┐ ┌ ┌ ┘ ┘

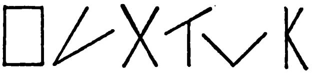
Example:



329.

With these lines: | | | | / / / / — — — — make 12 obtuse angles, each in a different position.

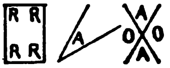
7. Draw:



330.

Write between the lines of each angle R for right angle, A for acute angle, and O for obtuse angle.

Example:



331.

8. By folding or cutting paper make right, acute, and obtuse angles.

9. With a knife, a carpenter's rule, etc., make and name the three kinds of angles.

10. On paper. Draw diagram 268, and by connecting dots make several right, acute, obtuse angles, and perpendicular lines in different positions.

Section 32.

TWO INCH LINES AND SPACES.

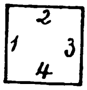
1. Work the two-inch paper square as you did the inch square in section 25.

Draw dots and lines as follows:

.1 .3 or .1 .2

.2 .4 .3 .4

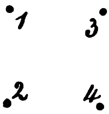
332.



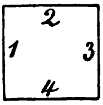
333.

2. On paper draw dots two inches apart, or lines two inches long.

(a)

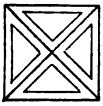


334.

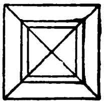


335.

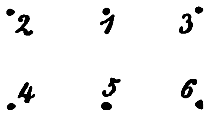
(b)



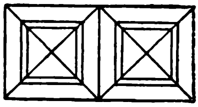
337.



338.



336.



339.

Copy figures 337, 338, and 339.

Section 33.

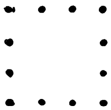
TRISECTING.

Trisect. 1. Cut, tear, break, sticks, straws, slips of paper, etc., into thirds.

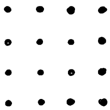
2. Draw a line upon the board or slate. Placing two fingers upon that line so as to make *three equal* parts, **trisect** (by erasing across). Repeat with lines in other positions.

3. **Trisect** the distance between two dots. (Do not draw three dots, instead of two, between the first two dots.)

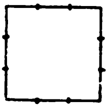
4. On paper:



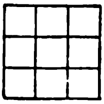
340.



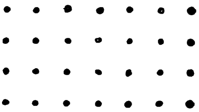
341.



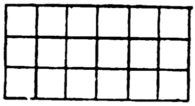
343.



344.



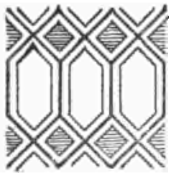
342.



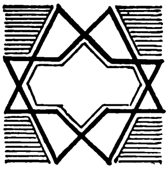
345.

Work these diagrams as usual. Remember former rules.

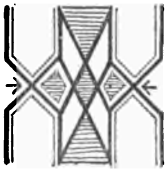
Samples :



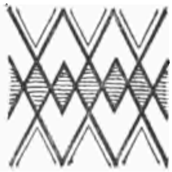
346.



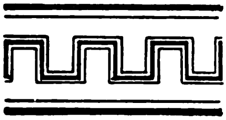
347



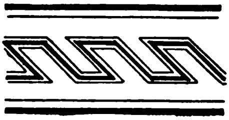
348.



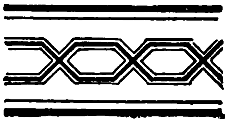
349



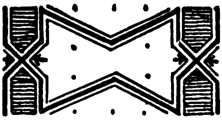
350.

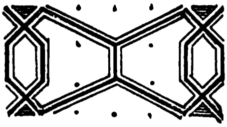


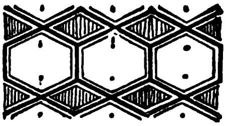
351.

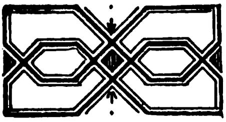


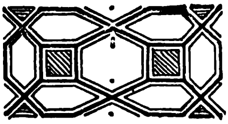
352.

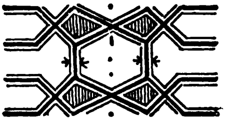

353.

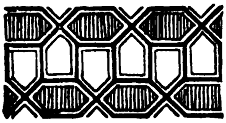

354.

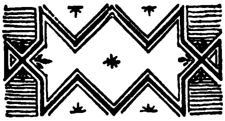

355.

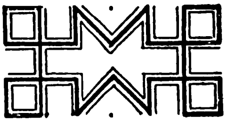

356.

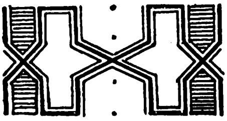

357.

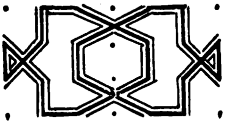

35 .

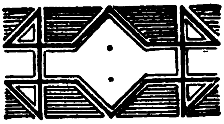

359


360

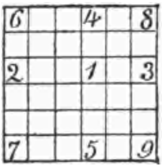

361.


362


363.

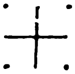

364.

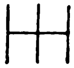
Section 34.

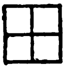


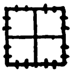
365.

(*a*) Draw center dot 1.
(*b*) Draw line 2–1, two inches long.
(*c*) Draw line 1–3, two inches long.
(*d*) Draw line 4–1, two inches long.
(*e*) Draw line 1–5, two inches long.

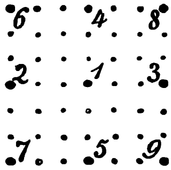

(*f*)


(*g*)


(*h*)


(*i*)

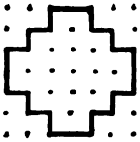
With dots.

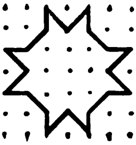


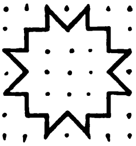
366

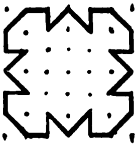
By leaving out a certain number of dots, other diagrams may be found.

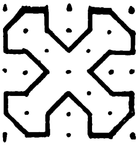
Either make a pattern as usual, or, drawing any one of the following outlines, divide its surface and improve it.


367.

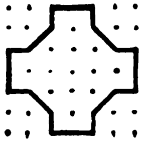

368.

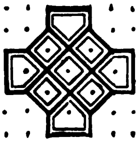

369.

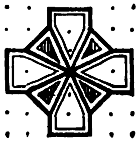

370.

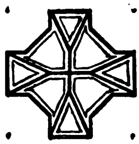

371.

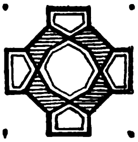
Samples:


372


373.


374.

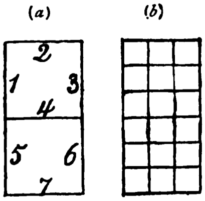

375


376.

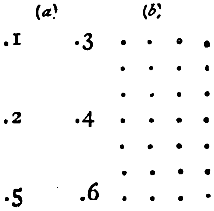
Section 35.

DOUBLE SQUARES (OBLONG).

Either with *light* two inch lines, or dots two inches apart—draw:



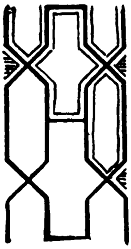
377.

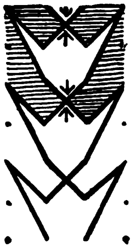


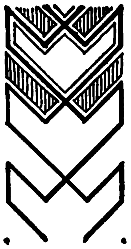
378.

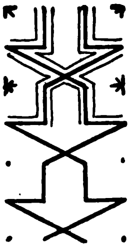
Make one or two patterns upon paper.

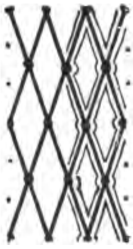
Samples:

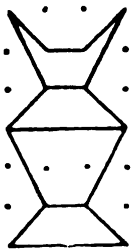

379.


380.

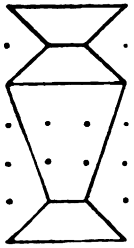

381.


382.

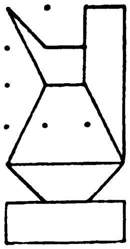

383.



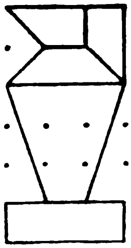
384.



385.



386.



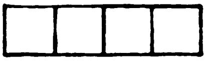
387.

Find others.

Section 36.

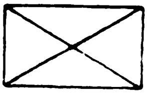
REVIEW.

1. Can you draw from memory:
   - (*a*) One and two inch lines?
   - (*b*) One and two inch squares?
   - (*c*) Four inch-squares in a horizontal row? ex:
   - (*d*) The same in a vertical row?
   - (*e*) Five inch-squares forming a cross?
   - (*f*) Nine inch-squares, forming a square?



388.

2. Draw:
   - (*a*) Parallel lines in 4 different positions.
   - (*b*) Perpendicular lines in 8 different positions.
   - (*c*) Right angles in 10 different positions.
   - (*d*) Acute angles in 10 different positions.
   - (*e*) Obtuse angles in 10 different positions.
   - (*f*) Squares in 2 different positions.
3. Find out the names of the 16 different angles in this oblong.



389.

4. (*a*) Let somebody dictate to you some of the figures you have drawn, as figures 350, 351, 352, 367, 368, 369, 372, 384, etc.

(*b*) Dictate one of these figures to a class-mate, or to your class. Try to make yourself understood by the others.

5. Of all the figures you have drawn during this term, draw from memory the one you like best.

RESUMÉ.

You should now be able:

1. To understand the meaning of the following words:

vertical,
horizontal,
oblique,
parallel,
perpendicular,
right angle,
acute angle,
obtuse angle,
bisect,
trisect,
vertex,
side,
diagonal,
diameter,
square,
margin.

2. (*a*) To keep the correct positions of body, slate or paper, and pencil.

(*b*) To draw light and bold lines rapidly, using the arm or the shoulder movement.

(*c*) To find out your mistakes by holding your work at a distance, without being reminded of it each time.

3. To draw:

(*a*) One and two inch spaces, lines and squares.

(*b*) Parallel lines, perpendicular lines, and the different kinds of angles in all positions.

4. To make patterns with straight lines upon the different diagrams of this chapter.

5. To distinguish one point or line from all others, and to copy any pattern made from your diagrams.

CHAPTER IV.

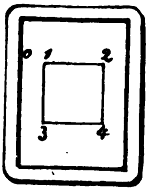
SECOND YEAR—SECOND HALF.

If you are not already drawing on paper, begin now. The sooner you stop using the slate, the better. The only exception is when you are trying to find out a new pattern; then it may be necessary occasionally to rub out wrong or unsatisfactory lines. This is easily done on slates and saves time. Even in this case it is preferable to use the blackboard to the slate.

Section 37.

FOUR INCH LINES AND SPACES.

Use a 4-inch paper square, as you did the inch-square in section 25. Enlarge diagram 341 (or 344) as follows:



390.

(*a*) Draw dot 0 upon the left side of your slate or paper, two inches from its upper left corner.

(*b*) Dot 1 is one inch horizontally from 0.

(*c*) Dot 2 is four inches from 1.

(*d*) Dot 3 is four inches vertically from 1.

(*e*) Dot 4 is four inches from 2 and 3.

See if these four dots are so placed as to be the corners of a future square.

(*f*) Trisect until you have figure 341.

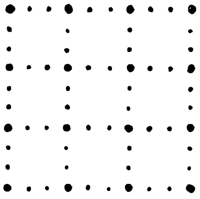
After reading rule 20, section 27, design a pattern, and draw it on paper.

See samples, section 33.

To have the square in the center of the paper (or slate), measure its dimensions. If, for instance, the paper is 6x8 inches, the square being 4x4, one inch is left for each right and left margin, and two inches for each upper and lower margin. Then find points 0, 1, 2, 3 and 4, as above.

Section 38.

TRISECTING.



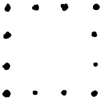
391.

(*a*) Repeat figure 390.

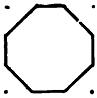
(*b*) Trisect.

(*c*) Make a pattern. Remember rule 20, section 27.

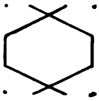
If any figures seem difficult, draw first the upper left hand corner square then the next, and so on. Examples



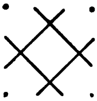
392.



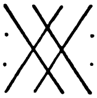
393.



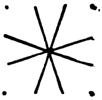
394.



395.

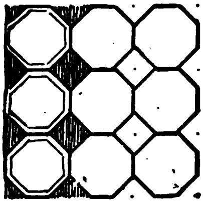


396.

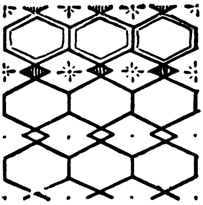


397.

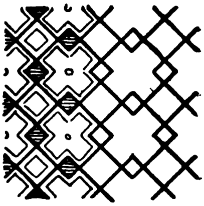
Corner squares of fig. 398, and following.



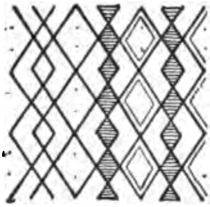
398.



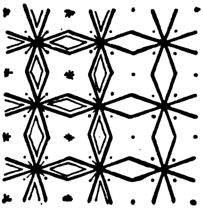
399.



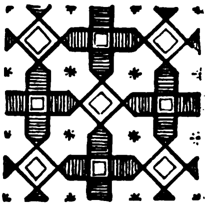
400.



401



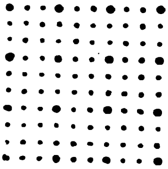
402.



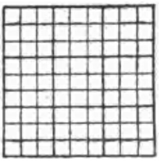
403.

Section 39.

Work as usual :

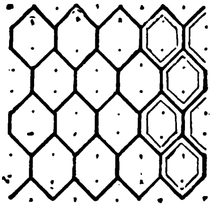


404.

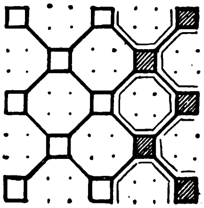


405.

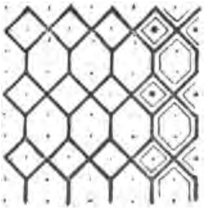
Samples :



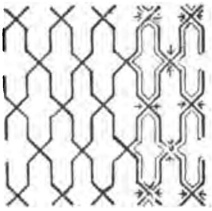
406



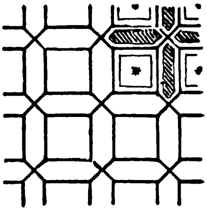
407.



408.



409.



410.

Section 40.

SIMPLE CURVES.

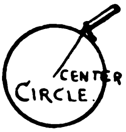
Bring to school a flexible *straight* stick (or a whalebone) and a string.

1. Hold the stick up: it makes a straight line; bend it: it becomes a **curve.** or

Now, hold the string stretched tightly between your two hands—it makes a straight line; loosen it a little—it becomes a curve, or curved line.

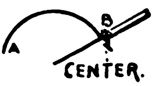
2. Tie the end of the string to the point of a pencil or crayon. Make (describe) a circle with it.

Write the words: *circle*, *center.*



411.

Try again, but do not go clear around the center, thus:



412.

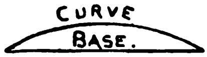
What is line A B? How many centers has it? A curve described from **one center** is a **simple curve.**

3. Make a bow with your stick and string. Draw the figure they make:

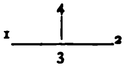
413.

The **base** of a curve is a straight line extending from one end of that curve to its other end.

Write:



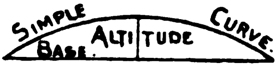
414.

4. Draw a four inch horizontal line, and upon its center erect a perpendicular one inch high  Without touching the slate or

paper with your pencil, move the latter several times through 1, 4, 2, making a *simple curve.* Do not stop at 4. Draw the whole curve with *one stroke,* using the arm or shoulder movement. Make both halves of the curve exactly alike.

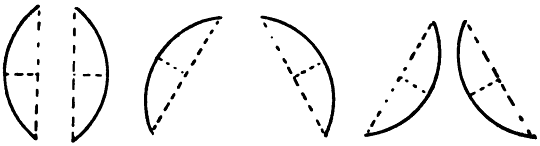
The perpendicular upon the center of the base gives the height of the curve above its base. It is called **altitude** or height.

Draw and write :



416.

Drawing first the bases, then the altitudes, draw in the same manner:

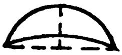


417.

Draw in different positions curves having

Bases =	4"	4"	3"	3"	3"
Altitudes =	2"	½"	1"	½"	1½"

Can you draw a curve whose altitude shall be ½ the length of its base? ¼—its base? —⅓ its base?



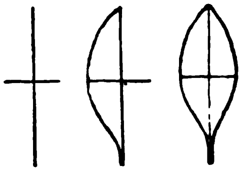
418.

Can you make a crescent by drawing two curves with the same base and different altitudes?

Can you make a leaf? See figure 419.

5. On paper:

Draw eight curves in different positions; a crescent; one or two leaves.



(*a*) (*b*) (*c*)

419.

Section. 41.

REVIEW.

1. Find out if you can do what is required in section 36. If not, review it.

(*a*) Draw a four inch square and divide it into nine equal squares.

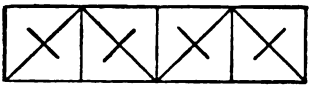
(*b*) Draw a simple curve having a four inch base and one inch altitude. Draw it again in 7 different positions.

(*c*) Draw a crescent in four different positions.

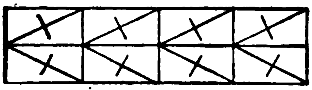
2. On paper:

Draw two oblongs each 4 inches long by one inch high.

(*a*)

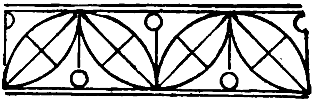


419.

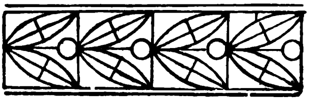


420.

(*b*)



421.



422.

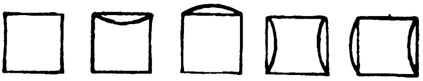
Section 42.

CHANGING STRAIGHT LINES INTO CURVES.

1. Can you make 10, 12, 15 different figures by changing one, two, three, or all four sides of a square into simple curves?

Begin by drawing the sides of the squares very lightly and rapidly. Do not make dots.

Example:

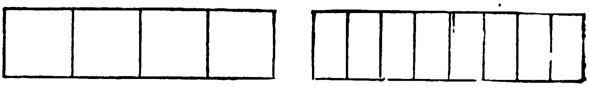


etc.

423.

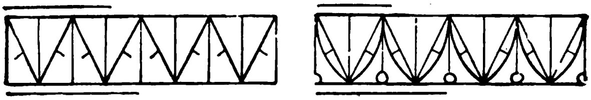
Give your curves **very small altitudes.**

2. On paper:



(*a*) (*b*)

424.



(*c*) (*d*)

425.

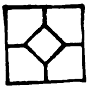
(*a*) Divide the page into halves by an horizontal line.

(*b*) Draw figure 424 in the upper half, and 425 in the lower half of the page.

(*c*) Each figure is 1x4 inches divided and worked as shown above.

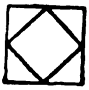
Section 43.

1. Change the straight lines of this figure 426 into curves.

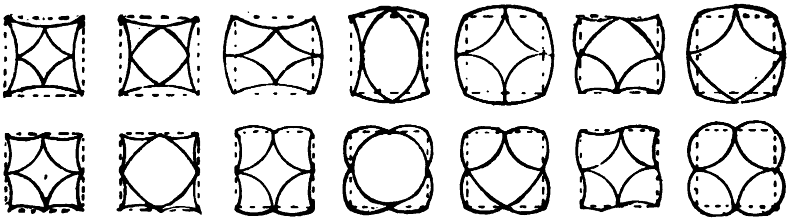


426.

Here is a sample: fig. 427 changed into curves (fig. 428).



427.



428.

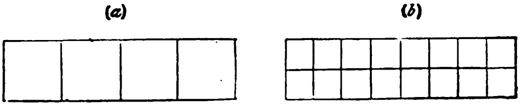
2. On paper:
(*a*) Draw figure 426 lightly.
(*b*) Change some or all of its lines into curves with small altitudes.
(*c*) Draw parallel lines.
(*d*) Line in.
3. Enlarge the same figure 3 or 4 times on the blackboard.

Section 44.

BORDERS.

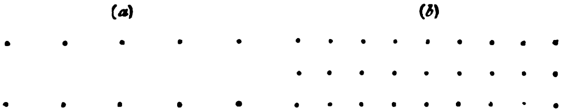
(*a*) Draw four squares, with bases of 1, 2, or 3 inches, on paper, or 4 to 6 inches upon the blackboard.

(*b*) Divide into 16 squares.



429.

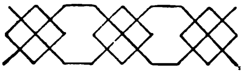
Or with dots:



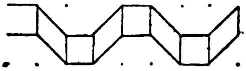
430.

(*c*) Make patterns with straight lines only. Improve them.

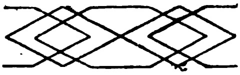
Samples:



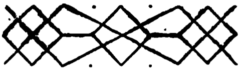
431.



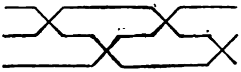
432.



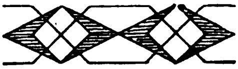
433.



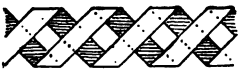
434.



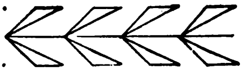
435.



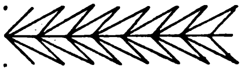
436.



437.



438.



439.

On paper.

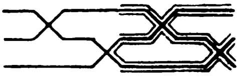
(*a*) Divide your page into halves.

(*b*) Copy two of your patterns.

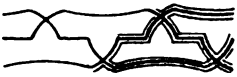
Section 45.

Change the straight lines of fig. 431 into curves.

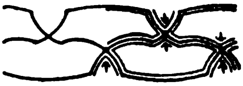
As a sample of your work here is fig. 435 changed into curves.



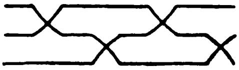
440.



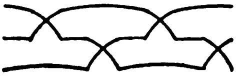
441



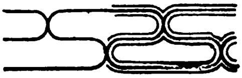
442.



443.



444.



445.

Section 46.

REPRODUCING OBLONGS OF ANY DIMENSIONS.

Bring to school several visiting and business cards, envelops, etc.

1. Draw and write:

Square.

Oblong.

What are your visiting cards; squares or oblongs? What kinds of angles in an oblong? What about the lengths of its sides?

2. (*a*) Put one of your cards upon your desk, in front of you. Look at it closely, but do not touch it until told to do so.

(*b*) Upon your slate or paper draw an horizontal line the exact length of the upper edge of your card.

(*c*) At the left end of this line, draw a perpendicular line the exact length of the left side of your card.

(*d*) In the same manner draw the right and lower sides of your oblong, which should be exactly the size of your card.

(*e*) Now apply your card to the upper and left sides of your oblong, and with a sharp pointed pencil rule along the right and lower edges of the card. Upon removing the card you will see your mistakes.

It is better to exchange slates and cards with another pupil, who will correct your work while you correct his.

(*f*) Write your name neatly in the center of your oblong.

3. Draw other visiting cards with the names of your teacher, father, mother, relative, friend, etc.

4. In the same manner draw an envelop and address it properly to your father or to some other person.

5. Try to draw the reverse or back of that envelop. Give it its true size.

6. You may draw the true size of your slate upon the blackboard.

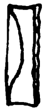
This is a very useful and practical exercise, because lines and surfaces are not always of an whole number of inches; also we must learn, little by little, how to represent comparative sizes in copying, enlarging or reducing.

Section 47.

NATURAL AND PAPER LEAVES.

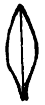
Bring to school natural leaves of the shape of figure 447.

1. (*a*) Fold a piece of paper, and cut it like this:



446.

Unfold it:

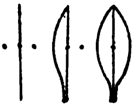


447.

This paper leaf may be prepared at home, or during recess.

(*b*) Fig. 448 shows you just how to proceed in drawing a leaf.

Of course, your lines should be of the size and shape of your paper leaf.



448.

(*c*) Put your paper leaf upon your drawing, and find out how near to the true size and shape of the leaf your drawing is. Try several times.

2. Sketch the natural leaf as you did the paper one, observing the distances between the edges of the leaf and its center rib or vein. Add the other little veins seen in that leaf.

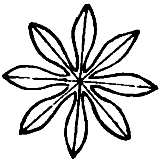
3. On paper:

Draw three or four natural leaves. If you can, write under each leaf the name of the plant bearing that leaf.

Could you make a border of leaves? Draw four leaves in a square.

Fold a piece of green paper so as to cut eight leaves around a center, figure 449.

Paste it upon white paper.



449.

Section 48.

REVIEW.

1. Trisect lines 1, 2, and 4 inches long.

2. With two-inch lines draw angles: one right, one acute, one obtuse.

3. Draw one of these angles in eight different positions.

4. Divide a four-inch square into nine equal squares.

5. Draw perpendicular lines in four different positions.

6. Draw (describe) a simple curve with base and altitude in eight different positions.

7. Describe a simple curve; base = 3″, altitude = 1″.

8. Dictate to the class fig. 404, 418, 426, 427, 429.

9. Make designs upon some of the diagrams given in this chapter.

10. Make a simple curve with a base twice the length of its altitude.

11. Draw the true shape and size of a visiting card; a paper leaf; a natural leaf.

12. Look for one minute at fig. 432. Close the book and draw this pattern from memory.

13. In the same manner draw figs. 391, 404, 405, 429, or 430.

14. Change into curves one of the following figs. 106, 108, 384, 386.

15. Of all the figures you have drawn during this term, draw from memory the one you like best

CHAPTER V.

THIRD YEAR—FIRST HALF.

Buy or make a book containing 16 pages, each 6x8 inches, or about that size. The quality of the paper does not matter, as *you are not allowed to erase anything on it.*

Observe rule 10.

Section 49.

THE CIRCLE. HOW TO DRAW IT.

You will advance in manual skill in proportion to your success in mastering the drawing of:

1. The straight line.
2. The simple curve or circle.

The latter is so important that this chapter is almost entirely devoted to it.

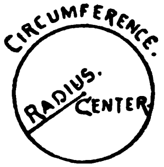
BLACKBOARD.

1. With a string and a crayon draw (describe) a circle. Write:

The **radius** (plural *radii*) is the length of the string from the center to the **circumference.**

A *radius* may be 1″, 2″, 4″, etc., or 1′, 2′, etc.

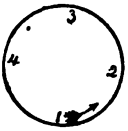
Could you describe a circle with a 5″ radius? a 9″ radius?



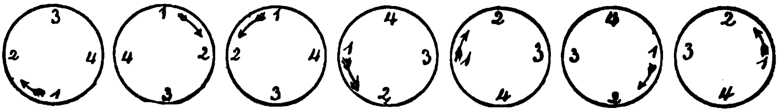
450.

2. **Exercise I.** To describe a circle of **any size,** free-hand, move the point of your pencil three or four times over the path of the intended circumference; then draw:

See at distance if your circle is ROUND. Compare it with the circle drawn with a string. Try again, and when you can describe this circle pretty well, change the direction and place of beginning. Example:



451



452.

This is an excellent practice for acquiring the power of moving your hand at will in all directions. It will improve your penmanship.

Repeat these exercises upon your slate and practice paper.

Make or procure a paper circle for next lesson.

To the Teacher.—"Do not weary your pupils by keeping them too long at work at any one time, with the circle, ellipse, and oval, but rather revert to them quite frequently, until they have fairly mastered their different features."—*Walter Smith.*

3. **In the book:**

To help you to draw the first page of your book neatly and lightly, a very easy figure is given.

(*a*) Draw diagram 247, section 26. Draw light dots.

(*b*) Select any figure from 112 to 145.

Draw *very light lines.* Read rules 11 and 12.

Section 50.

TRIANGLES.

RULE 21.

(*a*) Have a paper circle in front of you to look at.

(*b*) Use the shoulder movement.

(*c*) See that your figure is **round.**

(*d*) *Do not erase, measure, nor use mechanical means,* as strings, compasses, knuckles, etc.

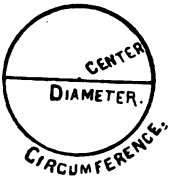
(*e*) Draw *lightly*, with a *slow* and *steady* stroke, stopping only when the curve is finished.

(*f*) Be not afraid of failures; keep trying, and you will succeed finally.

1. Practice exercises upon the circle in the last section.

2. Draw and write:

Tell what a **diameter** is.

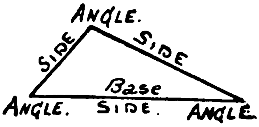


3. Draw an angle, and write the words *vertex, side,* close to the proper lines or point.

Draw a right angle in 6 different positions.
Draw an obtuse angle in 6 different positions.
Draw an acute angle in 6 different positions.

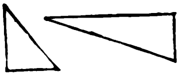
4. A plane figure, bounded by three lines, forming **three angles,** is called a **triangle.**

Draw and write:



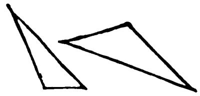
5. *All triangles* have at least *two acute angles.*

6. **A right-angled triangle** has **one** right angle. Example :



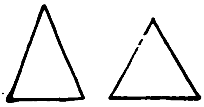
455.

7. An **obtuse-angled triangle** has **one** obtuse angle. Example :



456

8. An **acute-angled triangle** has **three** acute angles. Example:



457.

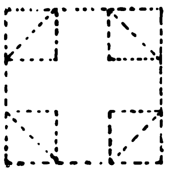
Construct *right-angled* triangles in four different positions.

Cut pieces of paper into triangles, and upon each write its proper name.

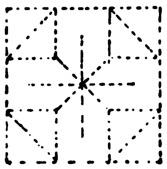
9. **In the book:**

Draw the following easy Byzantine pattern for mosaic work, made at the close of the 12th century, for San Lorenzo Fuori, in Rome.

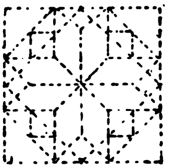
Divide a 4-inch square into 9 equal squares; then:



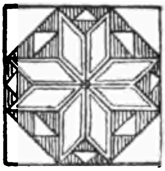
(a)



(b)



(c)



458.

If you use colored crayons or paints, the large triangles in the corners should be *red*, the shaded triangles light *blue*, the white triangles and rhomboids *yellow*. In the original, the division lines are *white*.

This figure may be executed by putting in the proper places colored papers, cut to the proper size and shape.

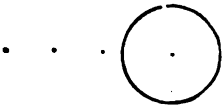
Section 51.

CIRCLE.

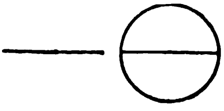
The difficulty of drawing a circle increases in proportion to the number of dots or lines it has to touch or pass through. The reason is that to the one idea —that of making a round figure—is added the perplexity of reaching given points, and sometimes crossing lines running in different directions, thus dividing positive attention in the mind.

Therefore, it is more difficult to describe circles by spacing dots for their circumferences, than by not using dots.

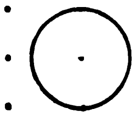
Exercise II. (*a*) Draw diameter, or the three dots. (*b*) Describe the circle. (*c*) Repeat, beginning at different points, and moving in different directions, as in figs. 451 and 452. (*d*) Observe rule 21, section 50.



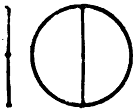
459.



460.



461.

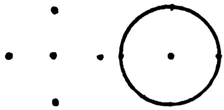


462.

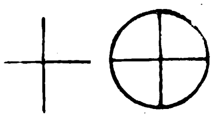
In practicing these exercises on the circle, make the diameters from 1 to 2 feet upon the blackboard, and from 2 to 8 inches on paper.

Work in the same manner :

Exercise III.
Five dots.

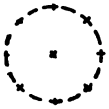


463.

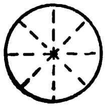


464.

Exercise IV.
Nine dots.

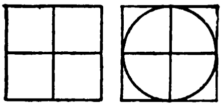


465.



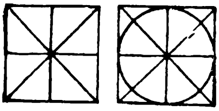
466.

Exercise V.
Inscribing a circle within a square.



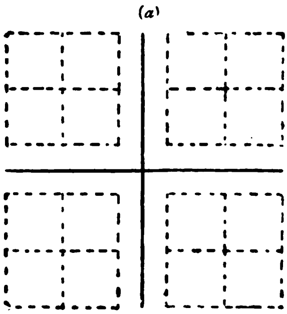
467.

Exercise VI.
Adding diameters and diagonals.

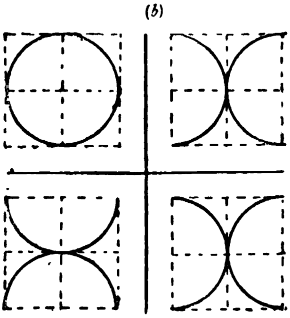


468.

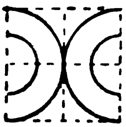
In the book:



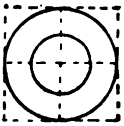
469.



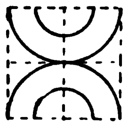
470.



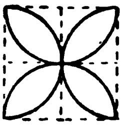
471.



472.



473.



474.

(*a*) Divide your page into fourths. In each construct a 2-inch square divided into four equal squares.

(*b*) Describe circles and semi-circles *very lightly* and boldly.

(*c*) Bisect the radii for the smaller curves.

Section 52.

Practice one of the *exercises* on the circle section 51.

Read rule 21, section 50.

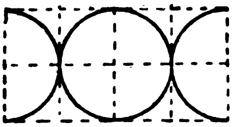
Practice broken lines. Do not use dots (. . . .) but dashes (— — — —).

Your pencil should be carried steadily forward and quite rapidly, touching the paper at intervals. Never stop until the desired point is reached.

Beginners should not sketch with a jerky movement, advancing a little, then returning.

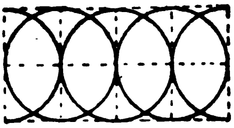
In the book:

(*a*)

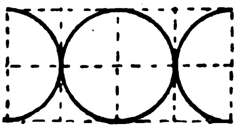


[illegible]

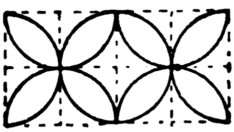
(*b*)



476.



475.



477.

(*a*) Divide page into halves.

(*b*) Draw diagrams (fig. 475) each 2 x 4 inches, in the center of each half page.

(*c*) Sketch with broken lines.

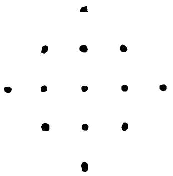
(*d*) You may add double or parallel lines.

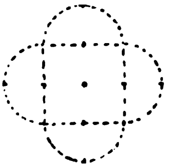
Section 53.

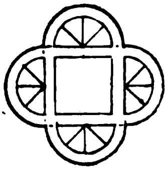
Practice one of the *exercises* on the circle, sec. 51. Observe rule 21.

With broken lines can you sketch a circle?

In the book :


(a)


(b)

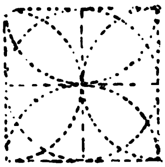

478.

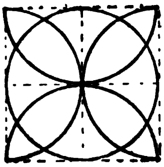
(*a*) Dots one inch apart.
(*b*) Sketch with broken lines.
(*c*) Parallel lines, ⅓ of an inch from the others. Line in carefully.

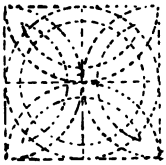
Section 54.

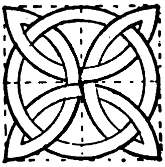
Practice one of the *exercises* on the circle, sec. 51. Observe rule 21 Sketch with broken lines.

In the book:


(a)


479.


(c)


480.

(*a*) Inscribe a circle in a 4-inch square. Sketch the four semicircles.

(*b*) Line in fig. 479.

(*c*) If you so desire, do not line in fig. 479, but sketch double lines, and then:

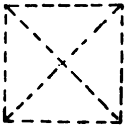
(*d*) Line in fig. 480. Be careful in interlacing.

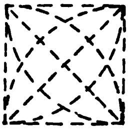
Section 55.

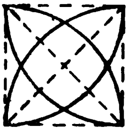
QUADRANTS OR QUARTER CIRCLES.

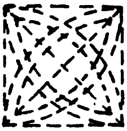
Practice one of the *exercises* on the circle, section 51. Observe rule 21. Sketch with broken lines.

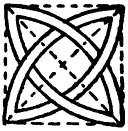
In the book:


(a)


(b)


481.


(c)

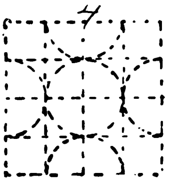

482.

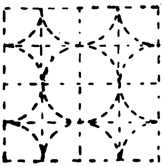
Proceed as in last section. Square = 4 inches.
Draw either fig. 481 or 482.

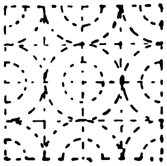
Section 56.

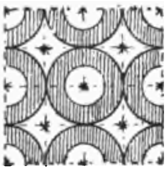
Practice one of the *exercises* on the circle, section 51. Observe rule 21. Sketch with broken lines.

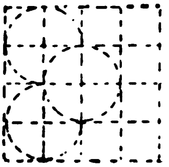
In the book:

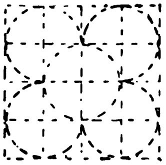

(a)

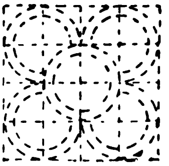

(b)

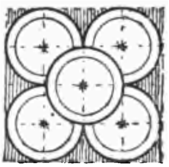

(c)


483.


(a)


(b)


(c)


484.

Draw either fig. 483 or 484,

(*a*) Square = 4″. Divide into 16 squares.

(*b*) Describe curves as shown.

(*c*) In figure 483 the double or parallel lines are ½ of an inch apart, and ¼ of an inch in fig. 484.

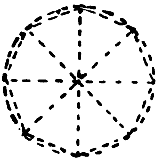
Line in and half tint.

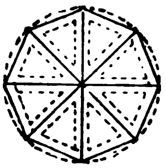
Section 57.

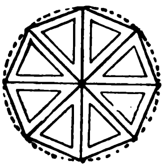
REGULAR OCTAGON.

Practice Exercise IV on the circle, section 51. Observe rule 21. Sketch with broken lines.

In the book,


(a)


485.


486.

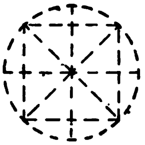
Draw either fig. 485 (without double lines) or fig. 486.
Radius of circle = 2″ or diameter = 4″. Divide into eighths.

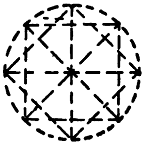
Section 58.

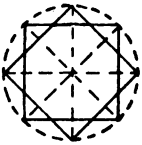
TWO SQUARES INSCRIBED WITHIN A CIRCLE.

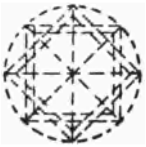
Practice Exercise IV on the circle. Observe rule 21. Use broken lines.

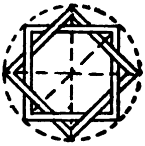
In the book:


(a)


(b)


487.


(c)


488.

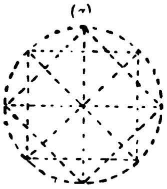
Copy either fig. 487 or fig. 488. Diameter of circle = 4″. Divide circle into octants. Connect every second dot upon the circumference.

Section 59.

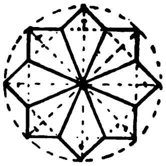
Practice Exercise IV on the circle. Observe rule 21. Use broken lines.

In the book:

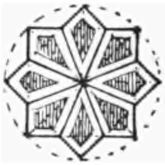
(a)


488.

(b)


489.

(c)


490.

Copy either fig. 489 or 490. Diameter = 4″.

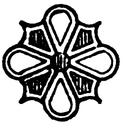
Section 60.

Practice Exercise IV on the circle. Observe rule 21. Use broken lines.

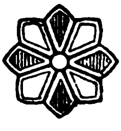
In the book:

Sketch very lightly fig. 489. Change some of its straight lines into curves. Draw parallel lines, half tints, etc. Place a small circle in the center.

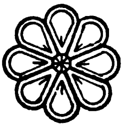
Samples:



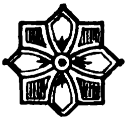
491.



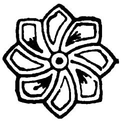
492.



493.



494.

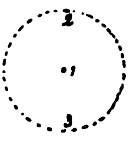


495.

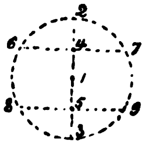
Section 61.

DIVIDING A CIRCLE INTO SEXTANTS (6THS).

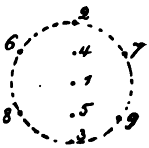
Practice Exercise II on the circle. Use the shoulder movement and broken lines.



(a)



496.



497.

Figs. 496 and 497.

(*a*) Divide diameter 2—3 into 4ths.

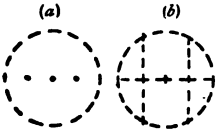
(*b*) Through dots 4 and 5 draw perpendicular lines 6—7 and 8—9.

(*c*) Dots 2, 7, 9, 3, 8 and 6 divide the circumference into 6ths.

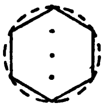
(*d*) Examine at distance, and correct.

Repeat with lines and dots in other positions.

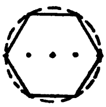
Ex.



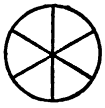
498.



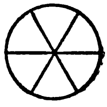
499.



500.



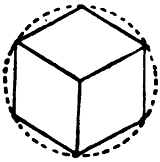
501.



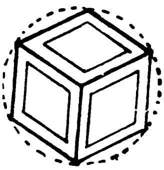
502.

In the book:

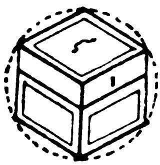
Draw fig. 503, 504, or 505. Circle = 2″ radius or 4″ diameter.



503.



504.



505.

(*a*) Draw fig. 499.

(*b*) Add the three radii, fig. 503.

(*c*) Add parallel lines, fig. 504.

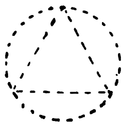
(*d*) Upper lid of the box = ⅓ the height (fig. 505).

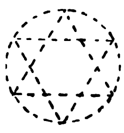
Section 62.

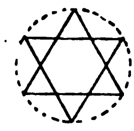
TWO EQUILATERAL TRIANGLES INSCRIBED WITHIN A CIRCLE.

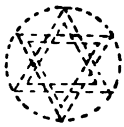
Divide circle into 6ths, as in fig. 497.

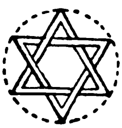
In the book:


(a)


(b)


506.


(c)


507.

Diameter of circle=4″. Draw either fig. 506 or 507.

Section 63.

In the book:

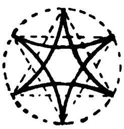
Draw fig. 506.

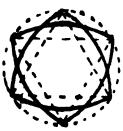
Change the straight lines of fig. 506 or 507 into curves.

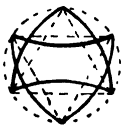
Make your own pattern, and copy it neatly in your book.

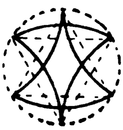
Diameter of circle=4″.

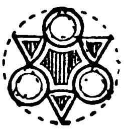
Samples:


508.


509.


510.


511.


512.

Section 64.

REVIEW. JAPANESE FAN.

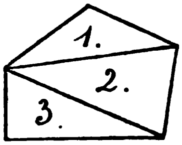
1st. Describe circles of the following dimensions: (*a*) 2″ radius; (*b*) 4″ diameter. Which is the larger circle of the two?

2d. Draw all the different kinds of angles, and write the name of each close to its vertex.

3d. Draw simple curves with altitudes: ½ its base;—¼ its base;—⅙ its base;—⅛ its base.

4th. Draw triangles: one right, one acute, and one obtuse-angled, and in the center of each write its proper name.

5th. Draw the following figure and write:

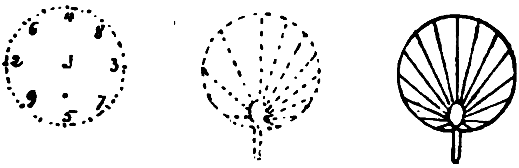


513.

1, ...angled triangle.
2, ...angled triangle
3, ...angled triangle.

6th. Draw oblique lines, 1, 2, 3 and 4 inches in length.

In the book:



(a) (b 514.

Diameter of circle = 4″.
Divide its circumference into 4ths, 8ths and 16ths.

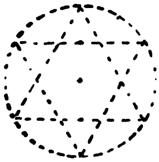
CHAPTER VI.

THIRD YEAR—SECOND HALF

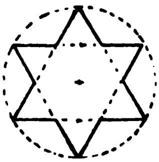
Section 65.

Practice *Exercises* on the circle, section 51. Observe rule 21. **Use** broken lines.

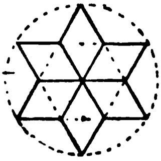
In the book:



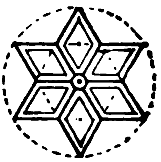
(a)



(b)



515



516

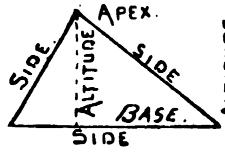
Copy either fig. 515 or 516. Diameter of circle = 4″.

Section 66.

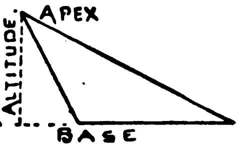
EQUILATERAL TRIANGLE.

Review briefly: Angles in section 31; Triangles in section 50.

Draw and write:



517.



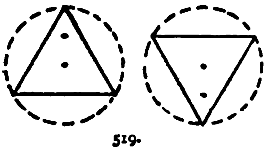
518.

The altitude (or height) is always *perpendicular* to the base.

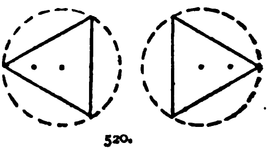
An equilateral (equal sided) **triangle** is an acute angled triangle **having three equal sides.**

How to draw it:

1st method:
See section 61.

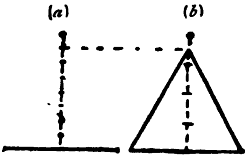


519.



520.

2d method:



521.

(*a*) Draw the base. Upon its center erect a perpendicular equal to the base. Divide that perpendicular into 8ths.

(*b*) Leave off the uppermost 8th. Draw the sides.

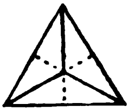
The *altitude* of an equilateral triangle is very nearly ⅞ the length of its base.

Turn your work about directly in front of your eyes, taking successively each side of the triangle as a base.

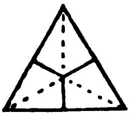
In all these positions the three sides must appear equal.

Do not measure. Trust your eye.

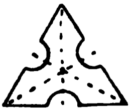
Can you divide an equilateral triangle into four equilateral triangles?—into sixteen? Can you draw?



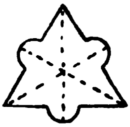
522.



523.

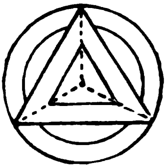


524.



525.

In the book:



526.

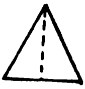
Diameter of circle = 4 inches.
Parallel lines ½ of an inch apart.

Section 67.

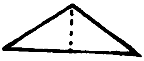
ISOSCELES AND SCALENE TRIANGLES.

An **isosceles** (isos = equal, sceles = legs) **triangle** has only **two equal sides.**

It may be an acute, an obtuse, or a right-angled triangle. Its altitude is upon the middle of its base.



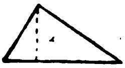
527.



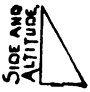
528.

Its base may be larger or smaller than its sides (figs. 527, 528). What would you call it, if its base were equal to its two other sides?

A **scalene** (limping) **triangle** has **no equal sides.**



529.



530.

It may be an acute, an obtuse, or a right-angled triangle.

Its altitude is never upon the middle of its base.

Triangles are named :

After their angles :

Right-angled triangle.
Acute-angled triangle.
Obtuse-angled triangle.

After the relative lengths of their sides :

Equilateral triangle.
Isosceles triangle.
Scalene triangle.

Can you draw :

A right-angled scalene triangle ?

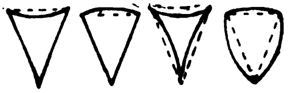
An acute-angled isosceles triangle ?

An obtuse-angled isosceles triangle ?

Cut triangular pieces of paper, and tell or write upon them their proper names, according to their angles and sides.

How many figures can you make by changing one, two, or all three sides of an isosceles triangle into curves ?

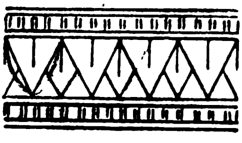
Ex :



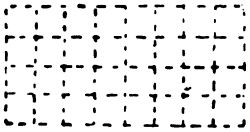
Find others :

531.

In the book :



532.



533.

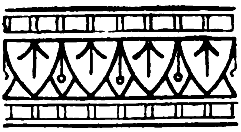
(*a*) Divide the page into halves.

(*b*) In each half draw 15 dots (fig. 226, section 24), and bisect spaces until you have 45 dots ; or draw fig. 533. Size of oblongs = 2″ x 4″.

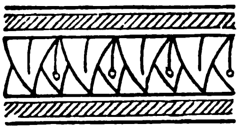
(*c*) Draw fig. 532 in the upper half of page.

(*d*) In the lower half of page, change fig. 532 into curves.

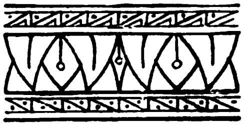
Samples :



534.



535.

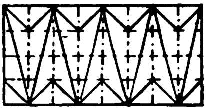


536.

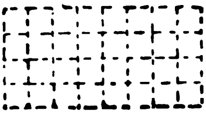
Section 68.

Practice exercises on the circle, section 51.

In the book:



537.



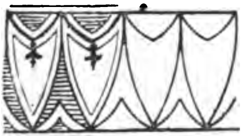
538.

(*a*) Draw same diagrams as in last section.

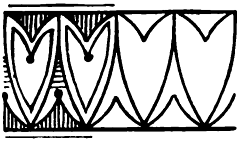
(*b*) In the upper half of page, change fig. 537 into curves.

(*c*) In the lower half of page, make a design.

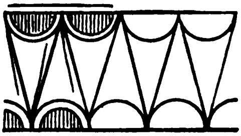
Samples:



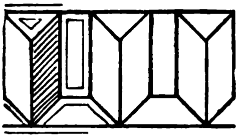
539.



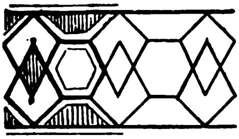
540.



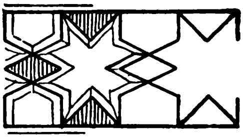
541.



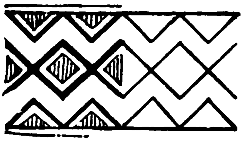
542.



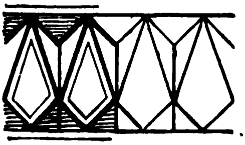
543.



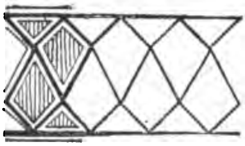
544.



545.



546.



547.

Section 69.

REVERSED CURVES.

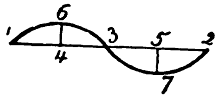
Here is a **reversed curve**:

Tell me why it is called *reversed.*

To draw it: (*a*) Make a 4-inch base.

(*b*) Divide it into 4ths.

(*c*) At points 4 and 5 erect ½ inch perpendiculars (6–4 and 5–7).

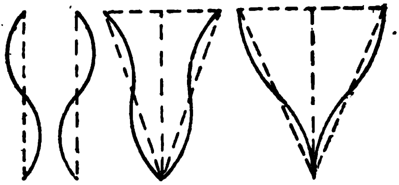


548.

(*d*) Make several times the motion of describing the curve, passing over 1, 6, 3, 7, and 2 without touching the paper with your pencil, then:

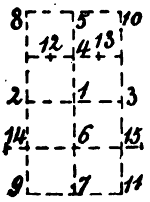
(*e*) Draw the curve lightly, slowly, steadily, never stopping until you reach dot 2. Examine it at a distance.

In the same manner, draw upon the blackboard:

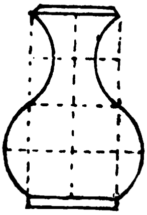


549.

In the book:



550.



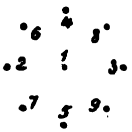
551.

Draw fig. 551.
Oblong = 2″ × 4″.
Altitudes = ½″ each.
Add lines above and below the oblong.

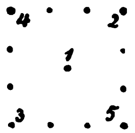
Section 70.

OBLIQUE LENGTHS.

Be careful to space dots accurately in this exercise.

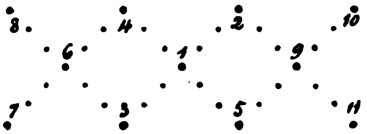


552.



553.

Fig. 552. Draw eight dots, each one inch from center 1, and equally distant from one another.



554.

Repeat this exercise with spaces 2, 3, 4, 8, 10, etc., inches between each dot and the center.

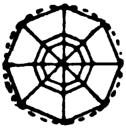
Exchange with a schoolmate and correct.

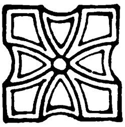
Fig. 553. Draw dots 2, 3, 4 and 5 at the same distance from center 1, making them the four corners of a square. Trisect.

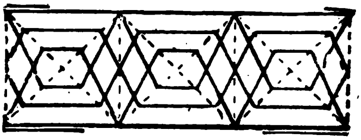
Fig. 554. Draw dots obliquely, so as to make the corners and centers of three equal squares. Trisect.

In the book:

Draw figs. 555, 556, in the upper half of the page, and fig. 557 in the lower half.

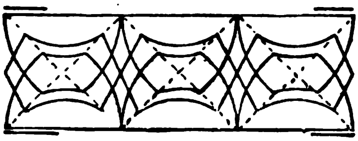

555.

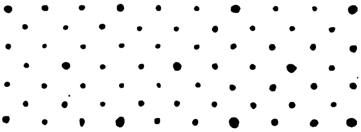

556.


557

You may change 557 into curves, (fig. 558.)

Should you prefer to make other patterns, here is a good diagram (fig 559), obtained by trisecting the spaces of fig. 554.

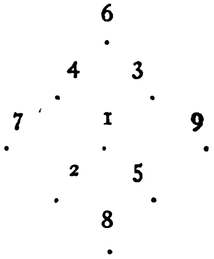

558.


559.

Section 71.

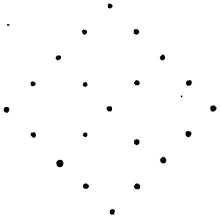
Draw obliquely, two inches apart:

(*a*)



Bisect.

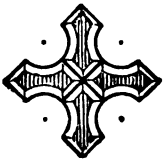
(*b*)

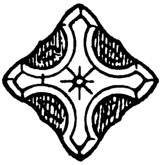

560.

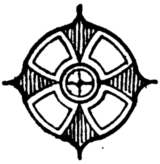
(*c*) Make a design.

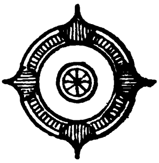
In the book: Copy your design.

Samples:


561.


562.


563.


564.

Section 72.

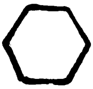
GEOMETRICAL WORDS—CIRCLE.

To the Teacher.

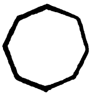
Review the words : Angle,
Triangle,
Equilateral,
Isosceles,
Scalene,
Circle,
Circumference,
Center,
Radius,
Diameter,

by either writing these words upon the blackboard, the pupils drawing the corresponding figures, or the teacher drawing the figures and the pupils writing their proper names.

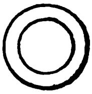
Draw and write :



565.



566.



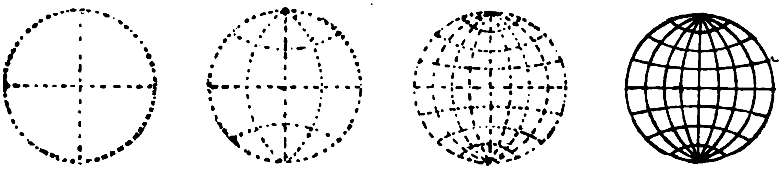
567.

Regular hexagon. Regular octagon. Concentric circles.

Regular polygons have equal angles and equal sides.

In the book:

Diameter of circle=4″.

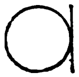


(a) (b) (c) 568.

Section 73.

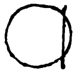
TANGENT LINES.

A line is **tangent** to a circle, when it **touches** it ; ex. :



569.

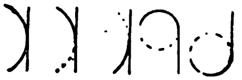
A line is **secant** to a circle when it **cuts** or crosses it ; ex :



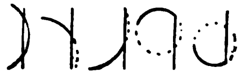
570.

It is the same with curves ; ex. : { Tangent :

Secant :



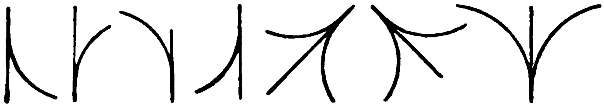
571



572.

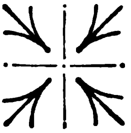
In nature, leaf stems are *tangent* to their branches; the branches are *tangent* to the trunk of the tree or plant.

Practice in all positions, drawing the straight lines first:

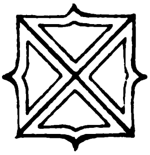


573.

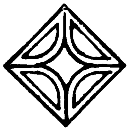
In the book:



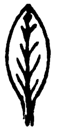
574.



575.



576.



577.

Details:
Draw two-inch squares.

Fig. 575.

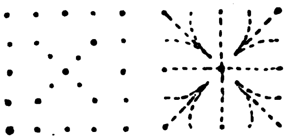
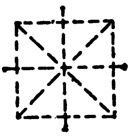


Fig. 574.



Extend diameters $\frac{1}{4}$ inch beyond the sides of the square.

Fig. 576.

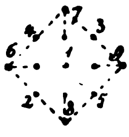
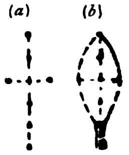


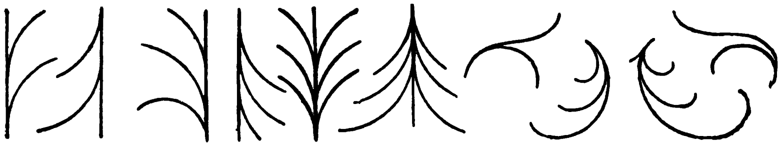
Fig. 577.



Height = $2\frac{1}{2}''$ divided into fifths. Width = $1''$. The lowest $\frac{1}{2}$ inch reserved for stem. Make both sides exactly alike.

Section 74.

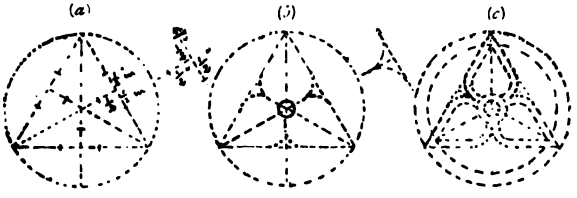
Practice off-hand in all positions.



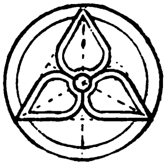
578.

Do not draw any *secant* line.

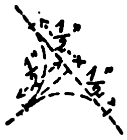
In the book:


(a) (b) (c)

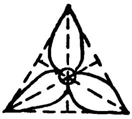
579.

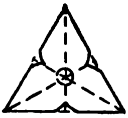

580.

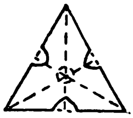
Line in either fig. 579 or 580.
Diameter of largest circle = 4″.
" " next concentric circle = 3″.
" " smallest " " = ½″.
Parallel lines are ¼ of an inch apart.
Tangent curves = ½″ radius.


581.

Avoid:


582.

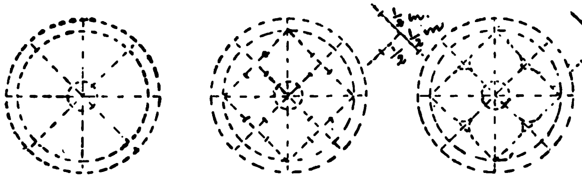

583.

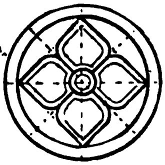

584.

Section 75.

Practice fig. 578, section 74.

In the book :


(a) (b) 585.

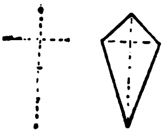

586.

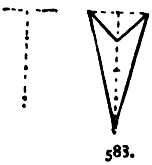
Line in either fig. 585 or 586.
(*a*) Diameter of circle = 4″ divided into 12ths.
(*b*) Tangent curves = ½″ radius, as in figure 581.
(*c*) Avoid such work as in figs. 582, 583, and 584.

Section 76.

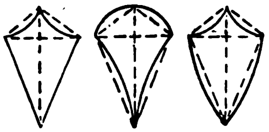
SYMMETRICAL TRAPEZIUMS.

Draw 1 x 2 inches :

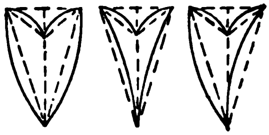

587.


583.

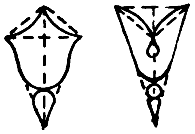
Changing the lines of fig. 587 and 588 into curves with small altitudes : Variations :



5 9.

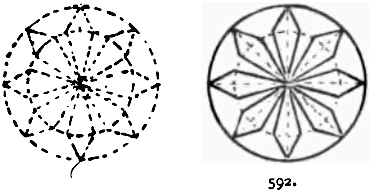


590.

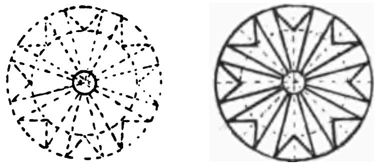


591.

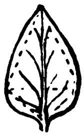
Rosettes are made by repeating any of these or similar figures around a center :



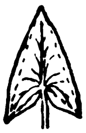
592.



593.



594.



595.

Have you seen leaves of these shapes ?

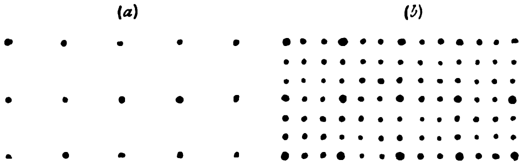
They are made by changing into curves fig. 587 and 588 and adding a stem.

Bring some leaves of these kinds to school. Find out the names of the plants bearing them. Draw them as well as you can. In selecting leaves for drawing, try to get some having both halves as nearly alike as possible.

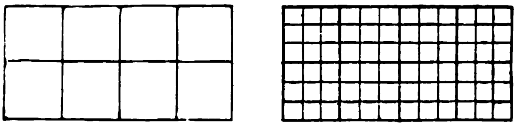
In the book : Copy a rosette like fig. 592 or 593, or leaves like fig. 594 and 595, writing the names of the plants from which the leaves have been taken.

Section 77.

Diagrams.



596.



597.

Whenever you have to draw many dots, it saves time to use *light lines.*

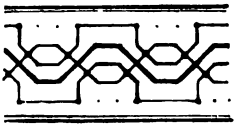
Make two designs. Use the least number of lines possible.

In the book: Draw two of your designs.

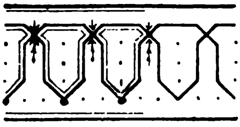
Oblongs = 2 x 4 or 2½ x 5 inches each.

You may use double lines, interlacing, coloring, etc.

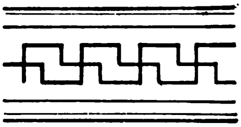
Samples:



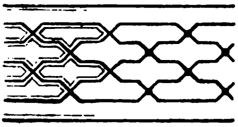
598.



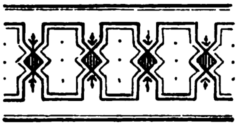
599.



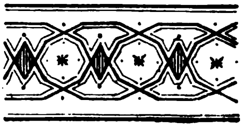
600.



601.



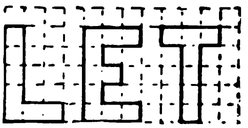
602.



603.

Section 78.

BLOCK LETTERS.



Draw twice fig. 596 or 597.

In fig. 604 leave off the upper row of squares.

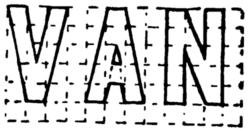
In fig. 605 leave off the lower row of squares.

Make your letters 5 squares high and 3 squares wide.

Can you print letters I, H and F Also letters K, X, Y and Z?

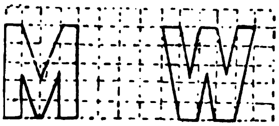
Draw oblique lines parallel to each other.

M is 4 squares and W 5 squares wide.



605.

Ex :



606.

In the book: Copy fig. 604 and 605, or similar ones.

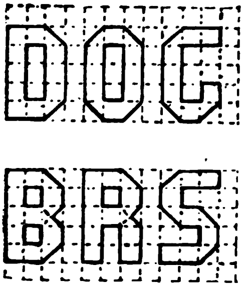
Oblongs = 2″x 4″ or 2½″x 5″.

Enlarge upon the blackboard.

Section 79.

Upon the blackboard, then

In the book:



607. 608.

Draw fig. 607 and 608, or similar ones. Work as in section 78.

Can you print letters C, J, Q, U?

Letter P is like the upper part of B.

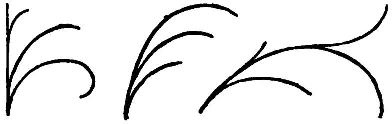
Can you make oblongs three or four times the length of these, divide them in the same manner, and print your name? —a short motto?—a sign?—a title?—initials?

Section 80.

REVIEW.

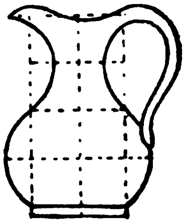
1. Draw a four-sided surface, containing one right, one obtuse, and two acute angles.
2. What angles does the altitude of a triangle make with its base?
3. Draw a scalene triangle with its altitude.
4. Draw:
    A right-angled scalene triangle.
    A right-angled isosceles triangle.
    An acute-angled isosceles triangle.
    An acute-angled scalene triangle.
    An obtuse-angled scalene triangle.
    An obtuse-angled isosceles triangle.
    Can you draw a right-angled equilateral triangle?
5. Divide a regular hexagon into six equilateral triangles.
6. Construct a regular octagon.
7. Draw tangent to each other:
    Two circles.
    Two curves.
    A line and a circle.
    A line and a curve.
8. Draw:
    A circle and a secant line.
    A curve and a secant line.

9. Draw off-hand any size:



609.

In the book:



610.

1. Draw from memory the figure you like best in Chapter VI, or any figure called for by the teacher.

2. If you prefer, change vase, fig. 551, § 69, into a pitcher.

Same dimensions as in fig. 551.

CHAPTER VII.

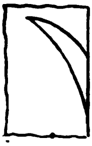
FOURTH YEAR—FIRST HALF.

—— Section 81. ——

SYMMETRY—DIVISION OF AREAS.

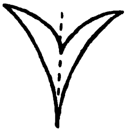
Symmetry consists in having a part of a figure **match, balance repeat** another.

Fold a piece of paper and cut it somewhat like this.



611.

Unfold:

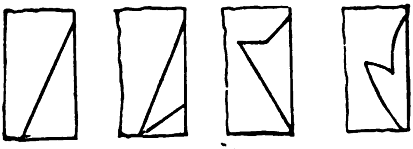


612

You have two parts, exactly alike, *matching*, *balancing*, *repeating* each other. These two parts are **symmetrical.**

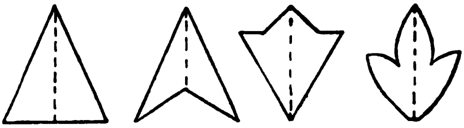
The division line made by the folding is an **axis of symmetry**.

Fold and cut paper as follows



613.

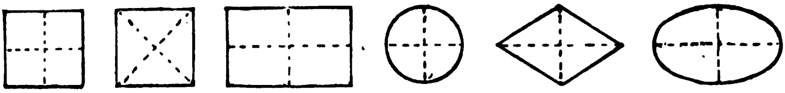
Unfold:



614.

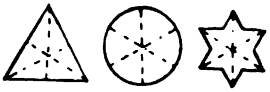
When two or more *axes of symmetry* meet in a point, that point is called a **center of symmetry.**

2 axes :



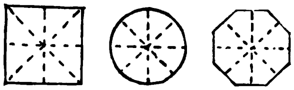
615.

3 axes:



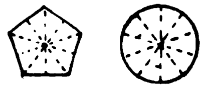
616.

4 axes:



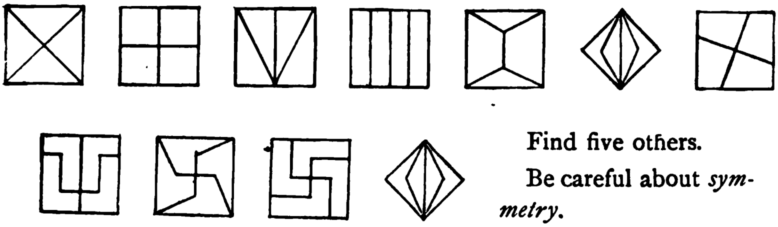
617.

5 axes :



618.

Can you divide squares into four symmetrical parts? Copy rapidly:

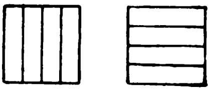


Find five others.

Be careful about *symmetry.*

619.

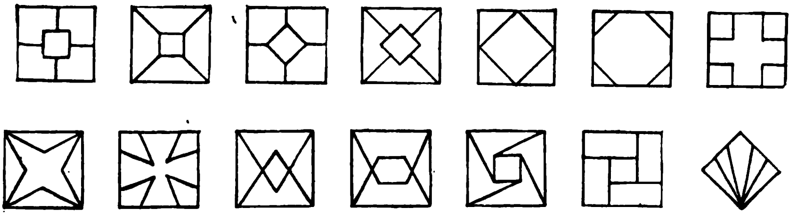
Also, do not draw the *same figure* in different positions, and call it another figure, as.



which is the same figure in two different positions

620.

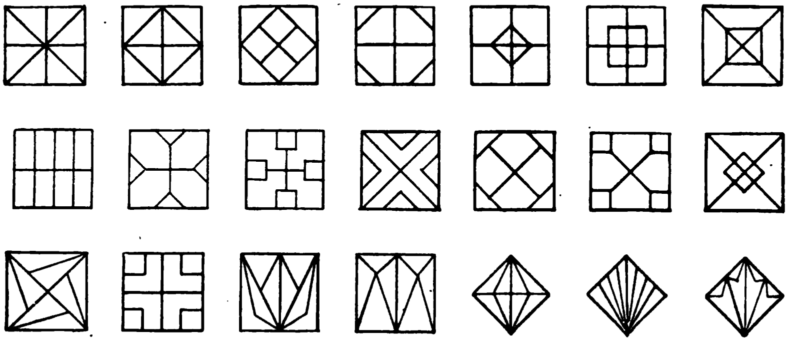
To divide squares *symmetrically* into five parts. Copy rapidly :



621.

Find five more. Use curves.

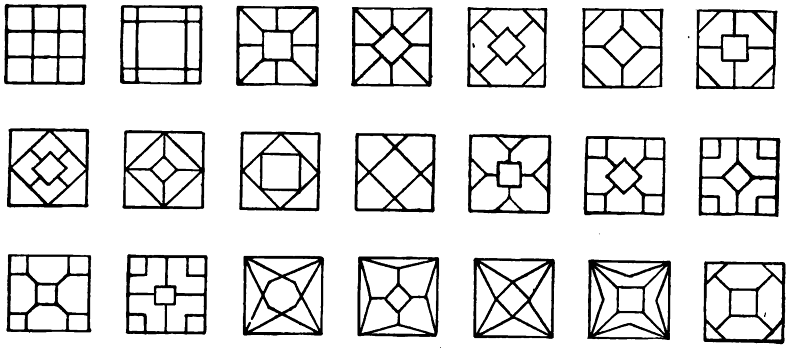
To divide squares *symmetrically* into eight parts. Copy rapidly:



622.

Find five more. Use curves.

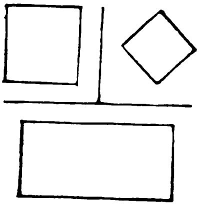
To divide a square *symmetrically* into nine parts. Copy rapidly:



623.

Find five others.

Oblongs are divided like squares.



624.

In the book: Draw fig. 624.

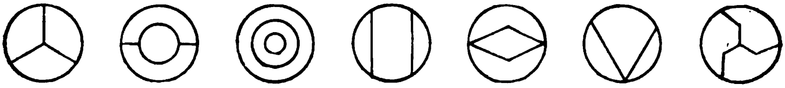
Squares = 2″. Oblongs = 2″ x 4″.

Divide symmetrically these figures. Improve with half tints, parallel lines, etc.

Section 82.

1. To divide circles symmetrically:

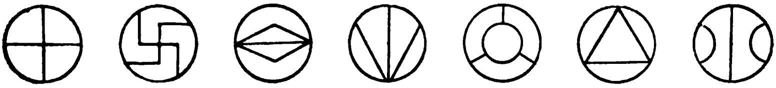
(*a*) Into three parts. Sketch rapidly:



625.

Find three others. Use curves.

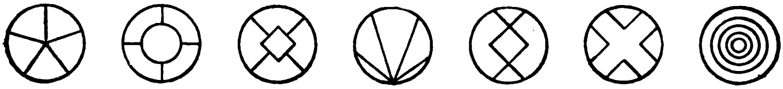
(*b*) Into four parts:



626.

Find three others.

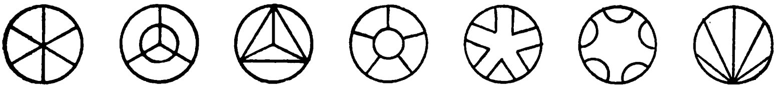
(*c*) Into five parts:



627.

Find three more.

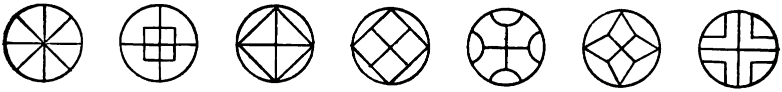
(*d*) Into six parts:



628.

Find three more.

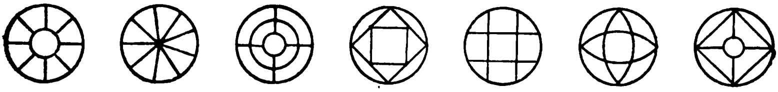
(*e*) Into eight parts:



629.

Find three more.

(*f*) Into nine parts:

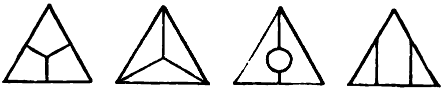


630.

Find three more.

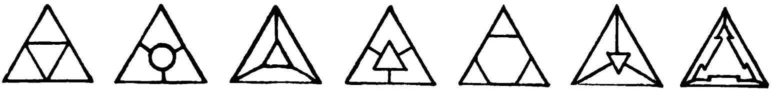
2. To divide equilateral triangles *symmetrically* into:

(*a*) Three parts. Copy rapidly:



631.

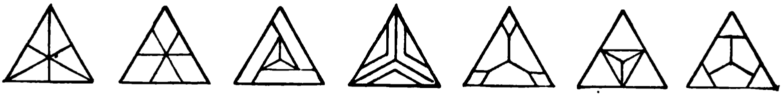
(*b*) Four parts. Copy rapidly:



632.

Find three more.

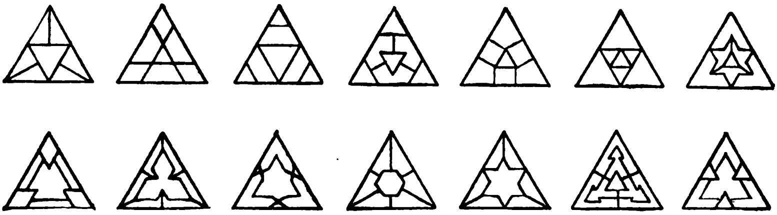
(*c*) Six parts. Copy rapidly:



633.

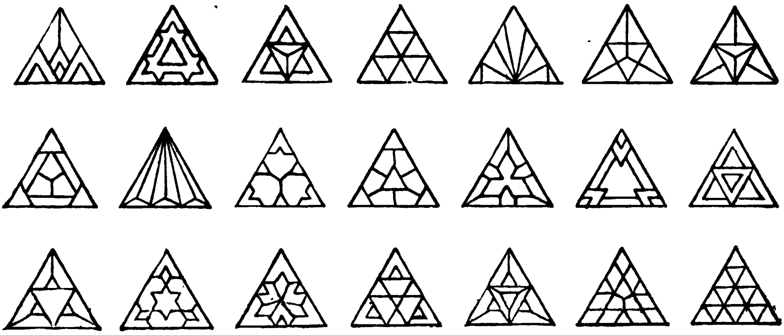
Find three more.

(*d*) Seven parts. Copy rapidly:



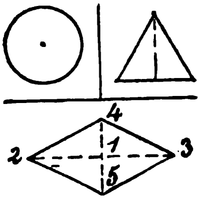
634.

(*e*) Eight, nine, ten, twelve, thirteen, fifteen, sixteen, etc., equal parts.



635.

In the book:



636.

Draw fig. 636.
Diameter of circle = 2″.
Equilateral triangle = 2″ base.
Diagonals of rhombus = 2″ and 4″.

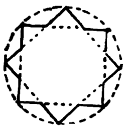
Divide symmetrically the circle, triangle, and rhombus. Add double lines.

The division of the rhombus is much like that of the square.

Section 83.

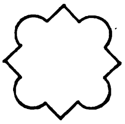
Upon the blackboard and

In the book:



637.

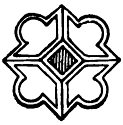
Draw fig. 637.
Diameter of circle on paper = 4″.
Make your own design.
Divide symmetrically.
Add parallel lines.



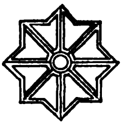
638.

Straight lines may be changed into curves, (fig. 638).

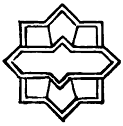
Samples:



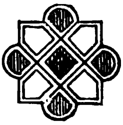
639.



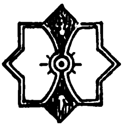
640.



641.



642.



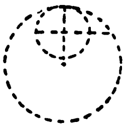
643.

Section 84.

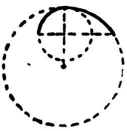
COMPOUND CURVES.

A **simple curve** is described from **one center.** (See sec. 40.) A **compound curve** has **two or more centers.** A reversed curve is a *compound curve.* (See section 69.)

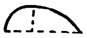
With a string or a pair of compasses, describe upon the blackboard:
Line in as in fig. 645.



644.



645.

Erase all except: 

646.

This is a *compound curve* with its base and altitude.

Notice that the altitude may not be upon the center of the base as in the simple curve.

RULE 22.

Compound Curves.

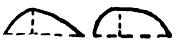
(*a*) Draw the base.

(*b*) Erect the altitude or altitudes at the proper places upon and perpendicularly to the base.

(*c*) Move the point of your pencil several times *over* the path of the intended line

(*d*) Describe the curve with a light, slow, steady stroke, stopping only when the whole line is finished.

(*e*) Use the arm or shoulder movement.

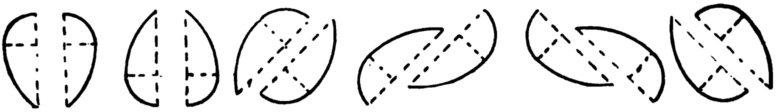
(*f*) Do not make angles. Ex: 

647.

(*g*) Examine your work at the proper distance.

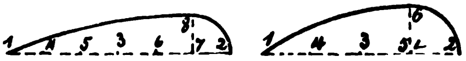
(*h*) It is well sometimes to sketch with broken lines.

Making the altitude ⅓ of the base, draw in different positions:



648.

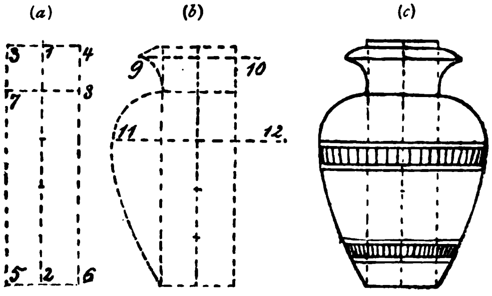
Change the divisions of the base, the length and place of altitudes.

Example: 

649.

Make curves 1–8 and 1–6 almost straight.

In the book:



650.

(*a*) Draw center line 1–2, five inches long. Divide it into 5ths. Make lines 1–3, 1–4, 2–5, and 2–6 each ⅜ of an inch. Draw oblong. Draw line 7–8.

(*b*) Line 9–10 is ¼ inch below line 3–4. It projects about one-half of an inch on each side of oblong. Line 11–12 projects one inch on each side. Sketch curves 3–9, 9–7, and 7–11–5.

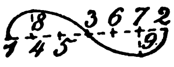
(*c*) Sketch the right side of the vase, making both sides alike. Ornament. Line in.

Notice that the ornamental lines are drawn closer together near the edges than in the center of the vase. Why?

Section 85.

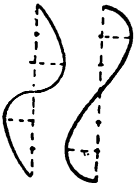
COMPOUND REVERSED CURVES.

Reversed curves may be made with *two compound curves* by placing their bases in a straight line.

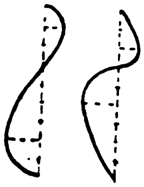


651.

In the same manner work in different positions:



652.



653.

In figure 652 the altitudes are 1/6 of the total height.

In figure 653 the altitudes are $\frac{1}{3}$ and $\frac{2}{3}$ of the total height.

Other *compound reversed curves* may be drawn by changing the proportions between the altitudes and their bases.

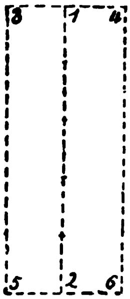
In the book:

Draw a vase of your own pattern, or one of the following:

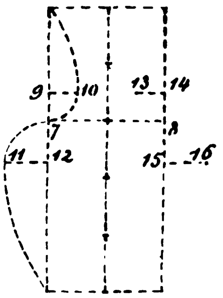
(*a*) Oblong = 2"x 5". Divide center line into 5ths.

(*b*) Bases: 3–7 = 2"; 7–5 = 3". Altitudes: 9–10 = ½"; 11–12 = $\frac{3}{4}$" Sketch the curves lightly. Do not stop from 3 to 5.

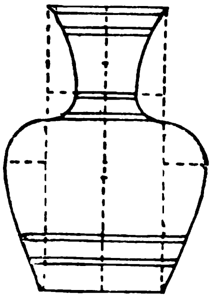
(*c*) Make both sides of the vase perfectly alike. Do not round the curve too much from 3 to 10 and 11 to 5, in fig. 654, and from 10 to 11 in fig. 655.



(*a*)

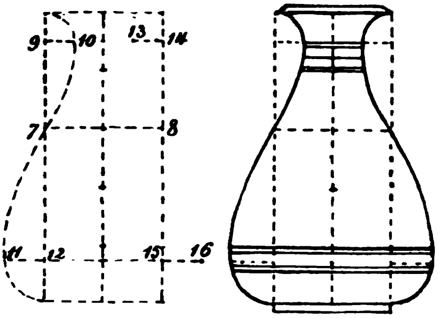


(*b*)



654.

Draw oblong as in fig. 654



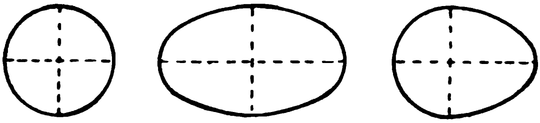
(a) (b) 655.

Section 86.

ELLIPSES.

If you have worked out faithfully the preceding chapters, you are now prepared to execute what is generally considered as much more difficult, although it is often really much less so. For instance, if you can draw a circle pretty well, you are as well able to draw an ellipse, an oval, and a spiral. In all these figures the motions are almost alike. The circle has been selected first, simply on account of the ease with which mistakes can be detected and corrected.

Use paper models. Draw and write upon the blackboard.



Circle. Ellipse. Oval.

656.

How do these three figures differ from one another? What about:

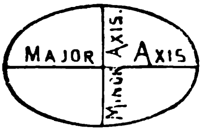
(*a*) The comparative lengths of their diameters.

(*b*) The angles those diameters make.

(*c*) The point where they cross each other.

(*d*) The comparative shape and size of the quarters of each figure.

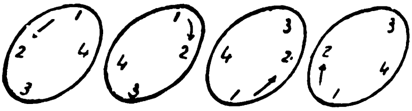
The diameters of an *ellipse* are called its AXES.



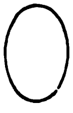
Are ellipses used in writing?

657.

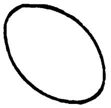
Practice with ellipses as you did with circles (section 49, exercise 1). First, any size and without axes.



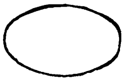
658.



659.



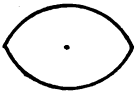
660.



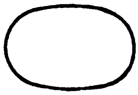
661.

Work figs. 659, 660, and 661 as fig. 658, changing the point of beginning.

Avoid:



662.



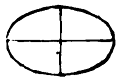
663.

With axes.

(*a*) Draw the axes at right angles, each line crossing the center of the other. Example :

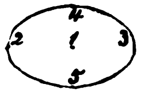
(*b*) Following the directions for the circle, describe the elliptical curve precisely through the extremities of the axes.

Example :



664.

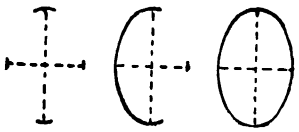
With dots :



665.

Draw your ellipses in all positions, *making the four quarters symmetrical.*

Here is another way to describe ellipses :

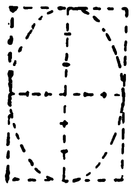


666.

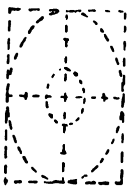
When one of the axes is, for instance, two lengths, and the other axis three lengths, the ellipse is called a 2 x 3 ellipse.

Can you draw 3 x 4, 3 x 8, 5 x 8 ellipses.

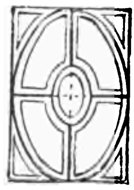
In the book :



(*a*)



(*b*)



667.

(*a*) Oblong = 3 x 4½ in. Inscribe a 2 x 3 ellipse within the oblong.

(*b*) Divide each axis into 6ths. Describe a small ellipse in the center.

(*c*) Double the lines and line in.

Section 87.

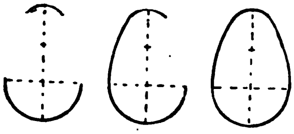
OVALS.

Practice the *oval* as you did the circle and the ellipse:

1st. Any size.
2d. Of a given size, with diameters.
3d. Enclosed in a rectangle.
4th. In different positions, and beginning the curve at different points.

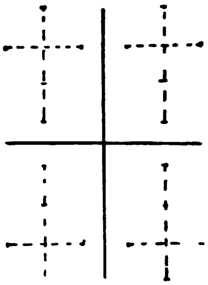
Can you draw 1x2, 1x3, 2x3, ovals?

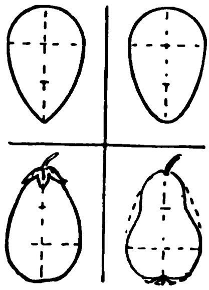
Here is another method of drawing ovals:


(a) (b) 668.

Draw upon the blackboard and

In the book:


669.


670.

Height = 2½" each; divide into 3ds.

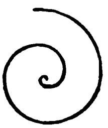
Width = ⅔ of the height.

(*a*) Draw fig. 669.

(*b*) Finish like fig. 670.

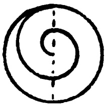
Section 88.

SPIRALS.

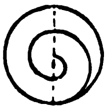
This  is a **spiral**. It consists approximately of semicircles.

671.

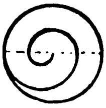
Draw four circles; divide their diameters into 4ths; through the points of division describe the following *spirals*:



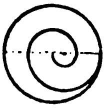
672.



673.

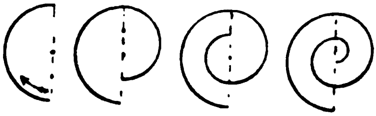


674.



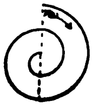
675.

Now, leaving out the circles, divide a line into 4ths and draw fig. 676, with *one* steady stroke; (*a*), (*b*), (*c*) represent the spiral at its different stages.

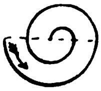


(*a*) (*b*) (*c*) 676.

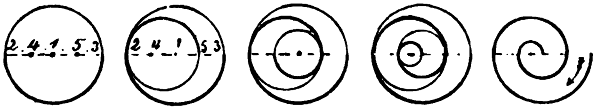
In a similar manner describe spirals, figs. 677, 678, and 679.



677.



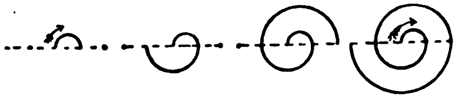
678.



(*a*) (*b*) (*c*) (*d*) 679.

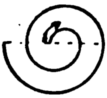
Fig. 679 shows, also, how a spiral is an extension of the compound curve.

Beginning in the center, draw:

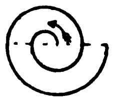


(*a*) (*b*) (*c*) 680.

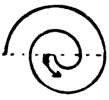
In the same manner:



681.



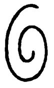
682.



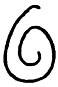
683.

Off-hand, without any line or dot, describe a spiral of any size, beginning at the outside or at the center. Keep your curve always at the same distance from that part of spiral drawn in the first revolution.

The ellipse and the oval furnish us with other kinds of spirals, ex.



684.

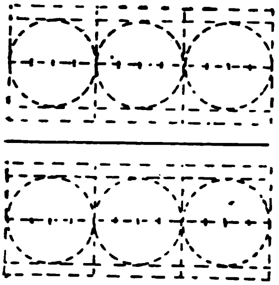


685.

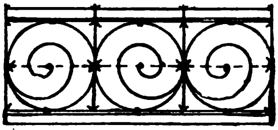
In nature, spirals are seen in young fern leaves, tendrils of climbing plants, feelers (antennæ) of some butterflies, coils of snakes, curls of hair, shells, etc. In manufactures, they are used in bed springs, watches and clocks, volutes of columns, etc

Bend wires into spirals. Combine two of them, of the same or of different sizes and shapes. Beautiful combinations are thus obtained.

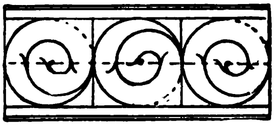
In the book:



686.



687.



688.

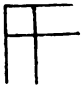
Draw fig. 687 and 688, or similar ones, taken from iron fences of spiral patterns. Oblongs = 2″ x 4½″ each. Small borders = ¼″ each. Inner squares and circles = 1½″.

Section 89.

MODIFYING CORNERS.

To make something better than a common square corner, work as follows:

1. **Four dot corners.**

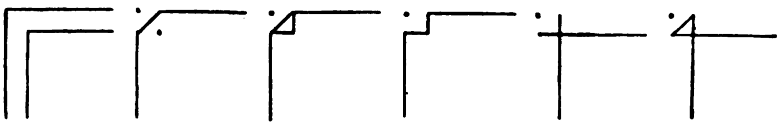


689.

or better

690.

Copy:

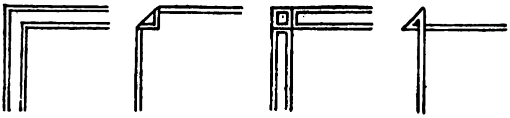


691.

Find three others. Do not draw curves.

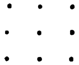
Improve them by drawing double lines.

Ex:



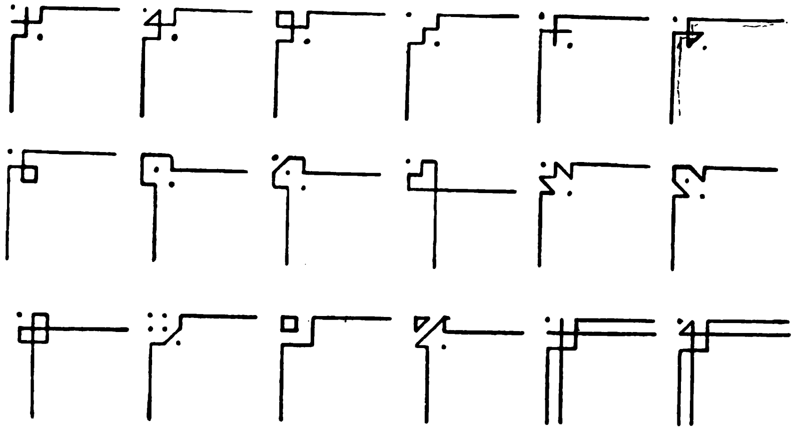
692.

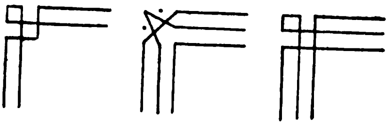
2. **Nine dot corners**:



Copy rapidly.

693.



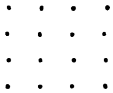


Find three more. No curves.

Improve by double lines and interlacing.

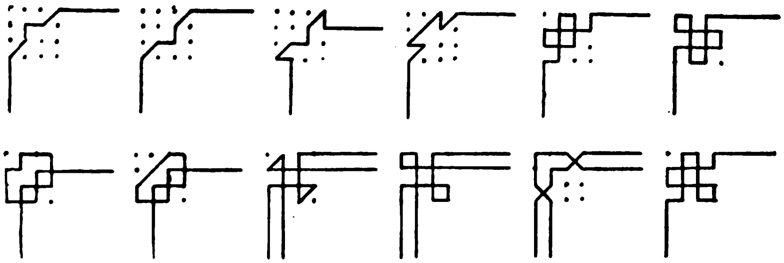
694.

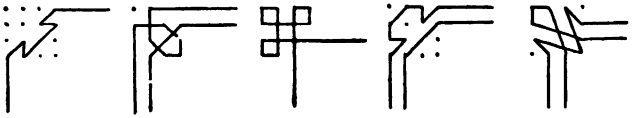
3. **Sixteen dot corners**:



Copy rapidly.

695.

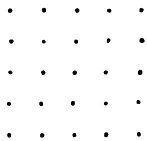




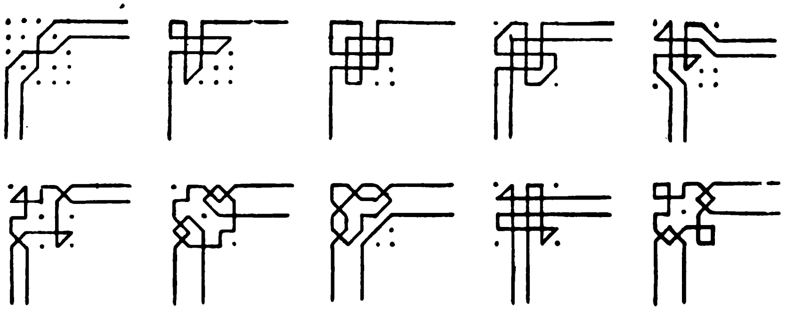
696.

Find three more. No curves. Double lining and interlacing.

4. **Twenty-five dot corners**: Copy rapidly.



697.

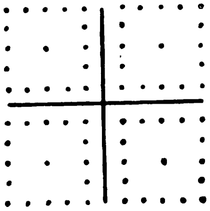


698.

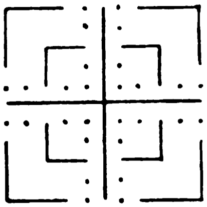
Find three more. Improve them.

Corners with 36, 49, 64, etc., dots are too complicated to be used here.

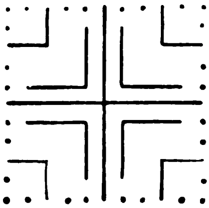
In the book:



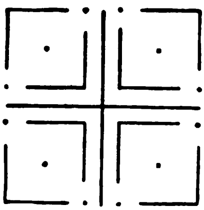
699.



700.



701.

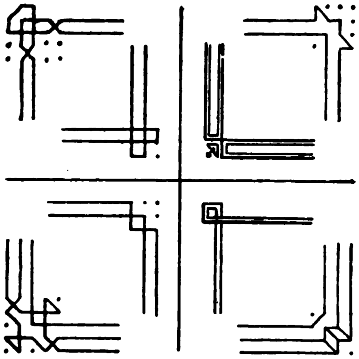


702.

Draw the eight corners you like best. Select corners having *few* lines. Do not use curves. Improve with double lines and by interlacing them.

You may use any of the following diagrams. Fig. 699 shows how to divide the page and space the dots.

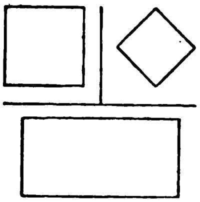
Sample page of corners.



703.

Section 90.

In the book:



704.

Squares = 2″.
Oblong = 2″x 4″.

Modify the four corners of each figure.

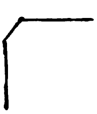
Do not change nearly the whole sides into corners. Make the four corners of the same figure alike. If you find it difficult to repeat the same pattern in the four corners, copy that pattern upon a separate piece of paper, which should be turned about and placed before you in the position wanted for each corner.

If time allows, divide symmetrically each figure and improve it with double lines. Do not use curves.

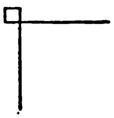
Section 91.

Select some of the simplest straight-lined corners to change into curves.

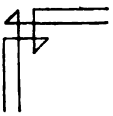
Example:



705.

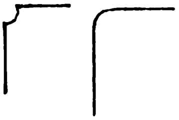


706.

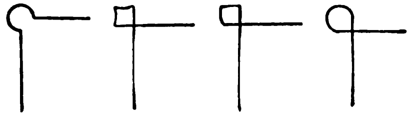


707.

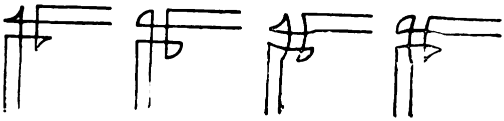
Changed into curves:



708.

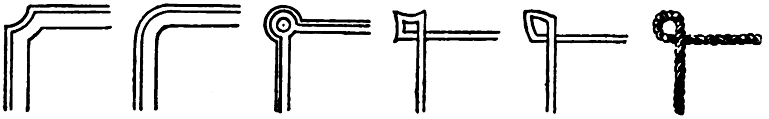


709.



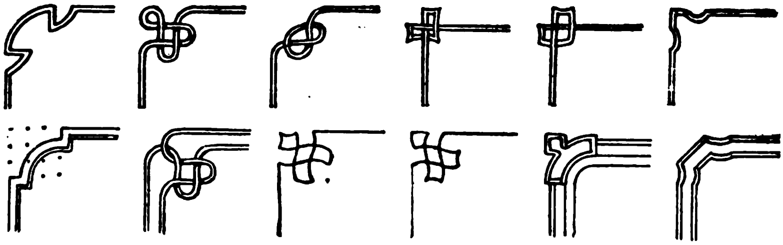
710.

Improved.



711.

Other improved corners.



712.

In the book:

Draw eight curved-lined corners, arranged as in one of the diagrams fig. 700, 701, or 702. Improve them with double lines, interlacing, shading, or coloring.

Section 92.

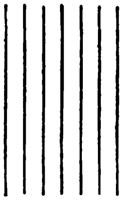
In the book:

Draw diagram fig. 704, and follow closely rules given in section 90. The only difference is the use of curves for the corners.

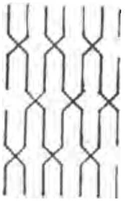
Section 93.

MODIFYING LONG LINES.

Long, parallel, unbroken lines are monotonous. (See fig. 713.) They should be broken symmetrically. (See fig. 714.)

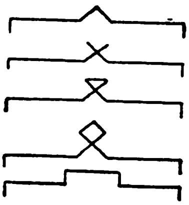


713.

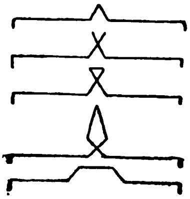


714.

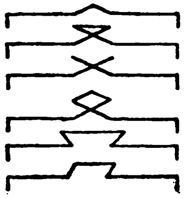
Copy rapidly these upper sides of squares (fig. 715). Change the angles (figs. 716 and 717).



715.

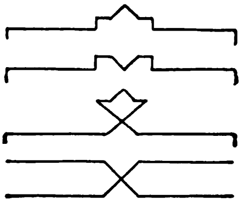


716.



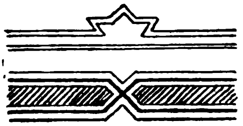
717.

Work in the same manner:



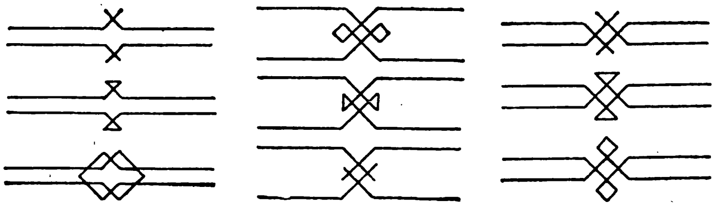
718.

Improve. Example:

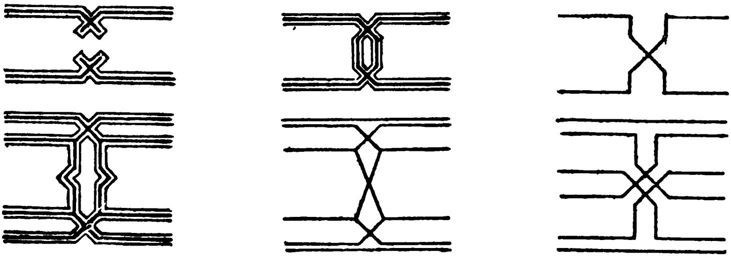


719.

Many patterns are made with the X and XX.



720.



721.

Change the lines of a few of these patterns into curves.

In the book:

Divide your page into 4ths, and in each space draw one or two of the above or similar patterns. Improve them.

Section 94.

In the book:

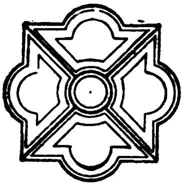
Draw lightly fig. 704, section 90.

Modify the middle of each line. Make the four sides of the same figure alike.

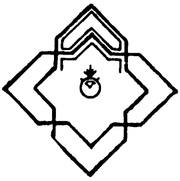
Do not modify nearly the whole side.

If time allows, improve the area of your figures.

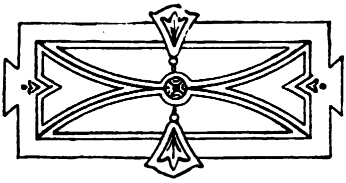
Samples:



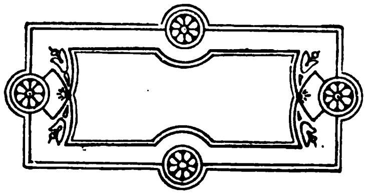
722.



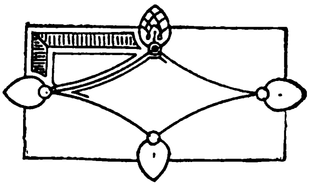
723



724.



725.

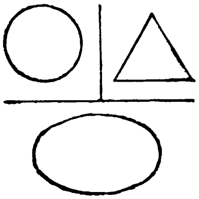


726.

Could you make a design for a breast-pin?—a card receiver?—a silver platter? or anything you can think of which will illustrate this section? Of course, a rough sketch of the above should be made beforehand, as you are not allowed to erase in your book.

Section 95.

In the book:



728.

Copy lightly fig. 728.

Circle = 1″ radius or 2″ diameter.

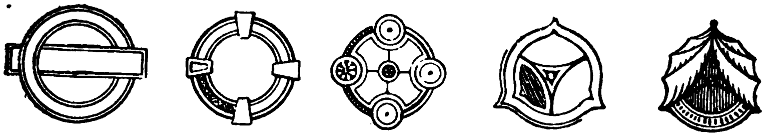
Equilateral triangle = 2″ base x 1¾″ altitude.

Ellipse = 2″ x 4½″.

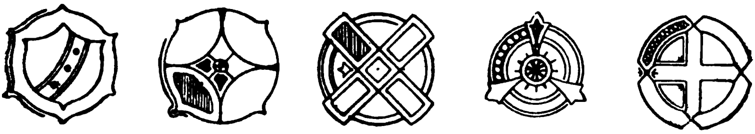
Modify the outlines of these figures.

Do not break the circumference of the circle into more than 2, 3, 4 or 6 places.

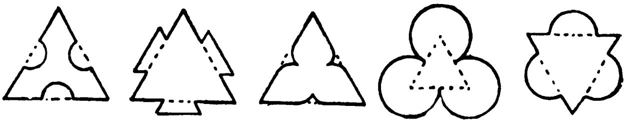
Samples :



728.

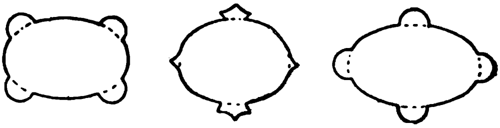


729.



730.

Treat the ellipse nearly like the circle.



731.

Section 96.

REVIEW.

1. Describe:
    Three concentric circles.
    An ellipse.
    An oval.
    A spiral.
    A compound curve with its base and altitude.
    A reversed compound curve with its base and altitude.
2. Divide symmetrically :
    A square into four parts.
    An oblong into five parts.
    A circle into three parts.
    An equilateral triangle into six parts.

3. Draw :

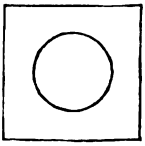
A 4 dot corner, (straight lines).
A 9 " " " "
A 16 " " " "
A 25 " " " "

Change the above into curves.

4. Modify :

The sides of a square.
The sides of an oblong.
The sides of an equilateral triangle.
The circumference of a circle.

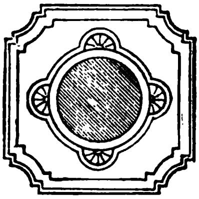
In the book:



732.

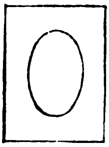
Improve fig 732.
Square = 4″.
Circle = 3″ diameter, or any other dimension.
Modify corners, middle of lines, draw parallel lines, etc.

Sample:

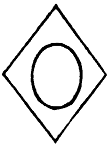


733.

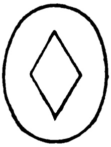
Instead of the above, you may improve figures like the following:



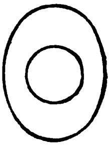
734.



735.



736.



737.

CHAPTER VIII.

FOURTH YEAR—SECOND HALF.

Section 97.

SECTORS—DEGREES.

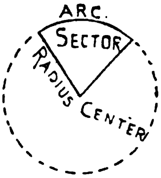
Draw and write:

What is a radius?

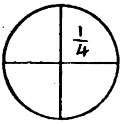
What are radii?

What is an arc?

What is the name of a figure bounded by an arc and two radii?



738.



739.
Quadrants
(or 4ths).

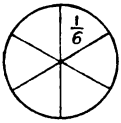
Describe a circle and divide it into four equal sectors. Write the individual name of each of these sectors.

Draw and write:

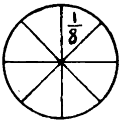
What is a sextant?

What is an octant?

What is the name common to quadrants, sextants, and octants?



740.
Sextants (6ths).



741.
Octants (8ths).

If you should divide a circle into 360 equal sectors, what individual name would you give to each of these sectors? Ans.: A degree.

This mark (°) means degree. Example: 4° reads four degrees.

The *arc* of such a sector is an arc of a degree. (1°)

The *angle* of such a sector is an angle of a degree.

How many degrees in a circle? In a quadrant? In sextant? In an octant?

How many degrees in the *arc* of a quadrant?

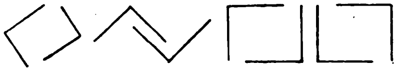
How many degrees in the *angle* of a quadrant?

What is the name of an angle of 90°? Ans. A right angle.

What is the name of an angle of more than 90°?

What is the name of an angle of less than 90°?

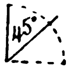
Draw a right angle in eight different positions.



742.

Let the two sides of each angle be perpendicular to each other.

To construct an angle of 45° draw:

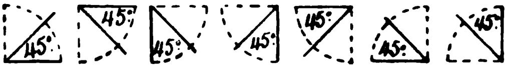


743.

(*a*) A quadrant. (*b*) Bisect it.

(*c*) See that the two halves are equal.

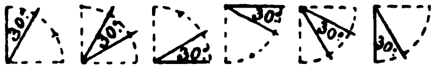
Draw lightly and rapidly.



744.

Draw angles of 30° in twelve different positions.

Ex:

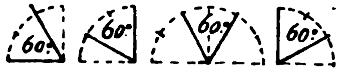


Find the others.

745.

Draw angles of 60° in twelve different positions.

Ex:

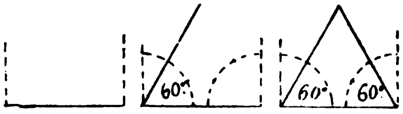


Find the others.

746.

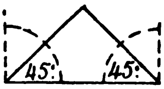
On a two-inch base construct an equilateral triangle.

Ex:

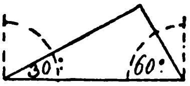


(*a*) (*b*) 747.

In the same manner draw:



748.



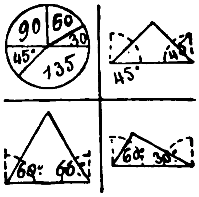
749.

These examples should be four to six times larger upon the blackboard.

In the book:

Diameter of circle = 2 inches.

Base = 2 inches each.



750.

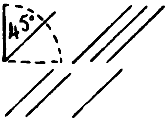
—— Section 98. ——

QUADRILATERALS.

The *right angle* is the natural standard of comparison for the other angles. This is why we are using the quadrant to find out angles of 30, 45, and 60 degrees.

Before taking up the quadrilaterals, let us drill upon the drawing of lines parallel to the sides of given angles.

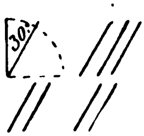
Draw :



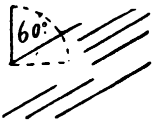
Examine at a distance if your lines are really parallel.

751.

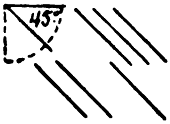
Work out rapidly, though carefully:



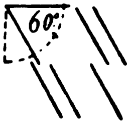
752.



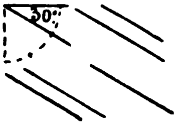
753.



754.



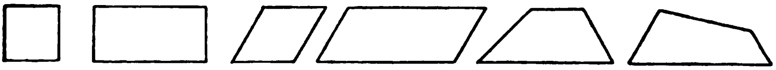
755.



756.

Quadrilaterals.

Draw and write :



Square. *Oblong.* *Rhombus.* *Rhomboid.* *Trapezoid.* *Trapezium.*

757.

How many sides in each of these figures? How many angles?
Which *quadrilaterals* have their opposite sides parallel?
Which *quadrilateral* has only two sides parallel?
Which quadrilateral has none parallel?
Which have four right angles? (Rectangles.)
Which two have four equal sides?
Which have two of their parallel sides longer than the other two?

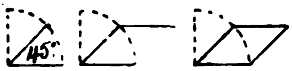
With wooden toothpicks make a square upon your desk. Change it into a rhombus.

Make an oblong with toothpicks. Change that oblong into a rhomboid;—into symmetrical trapeziums. (See fig. 587 and 588.)

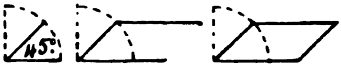
What kinds of angles in a rhombus? In a rhomboid?

What is the difference between a square and an oblong? A square and a rhombus? A rhombus and a rhomboid? A trapezium and a trapezoid? An oblong and a rhomboid?

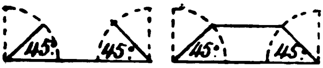
Draw and write:



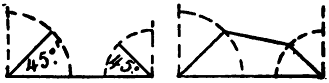
(a) (b) 758 (Rhombus.)



(a) (b) 759 (Rhomboid.)

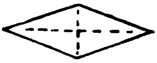


(a) 760 (Trapezoid.)

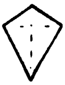


(a) **761 (Trapezium.)**

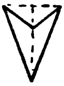
Can you draw, using any angle:



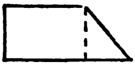
762.



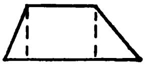
763.



764.

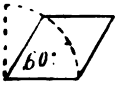


765.

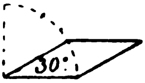


766.

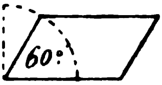
With the following angles:



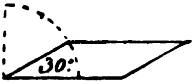
767.



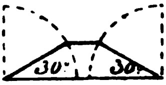
768.



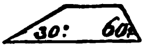
769.



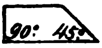
770.



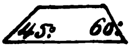
771.



772.



773.



774.

In the book:

Draw:

A Rhombus.	A Trap. zoid.
A Rhomboid.	A Trapezium.

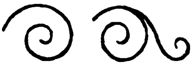
Under each figure write neatly its proper name.

Section 99.

SPIRALS.

Read rule 22, section 84.

Draw:

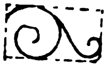


775.

The curves should be ***tangent.*** Repeat in all positions.

Irregular forms are often enclosed in regular geometrical figures, as squares, oblongs, circles, etc., in order to find out more readily the differences of their lines in direction and distance.

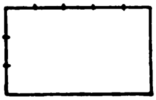
Ex.:



776.

Lines are not always measured by inches and feet. Any other *length* may be taken as a *unit.* Thus, a **length** may be contained 2, 3, 4 times into another.

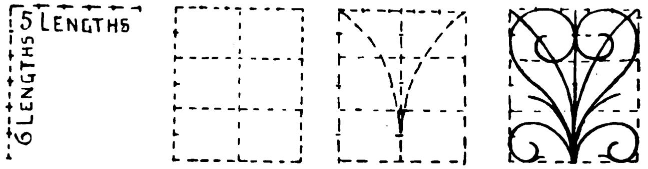
This oblong



is 3x5 *lengths.*

777.

Draw lightly and rapidly:
Oblong, 5x6 lengths.

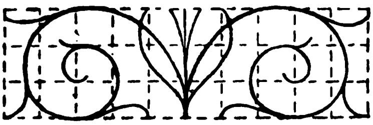


(a) (b) (c) 778.

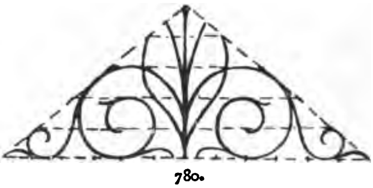
Work in the same manner:

Oblong, 3x10 lengths.

Triangle.—Base = 12 lengths.
Altitude = 5 lengths.



779.



780.

If possible, bend pieces of wire into spirals, and mount these and similar patterns with putty, soaked peas, or hair wire.

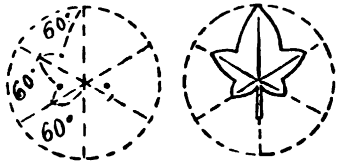
In the book:

Draw to any convenient size any of the foregoing figures, or others of the same kind you may find or invent.

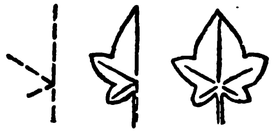
Section 100.

Angles are often used to determine the course of irregular curves: with angles the surveyor *maps out* the meanderings of creeks and rivers, mountain sides, etc.; the artist *blocks out* the heads and bodies of animals, foliage, etc.

The ribs of an ivy leaf make angles of about 60 degrees. Ex:



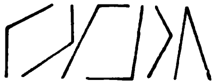
781.



782.

Angles of any number of degrees are made besides those of 30, 45, 60, and 90°.

Can you draw angles exactly like these?

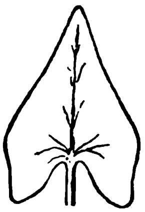


783.

At arm's length, compare your work with these figures.

NOTE. You may draw these angles with long or short lines; the *length* of a side *has nothing to do with* its *direction.*

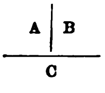
Block out and draw:
(Morning glory leaf.)



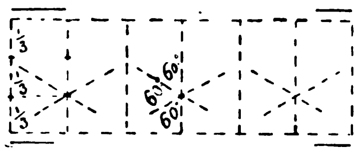
784.

Bring to school other kinds of leaves. Block them out, using proper angles, and draw them. Select leaves having their two sides as nearly alike as possible.

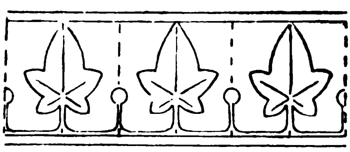
In the book:



Draw one blocked-out leaf in space A; another in B; in C, draw a border of leaves. You may copy the following:



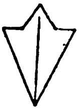
(a)



785.

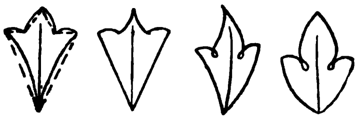
Section 101.

Change into curves :



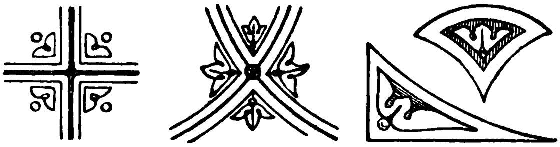
786.

Samples :



787

Sketch rapidly :

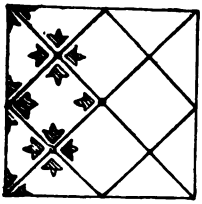


788.

Notice that ornaments always take the shapes of lines surrounding them.

In the book: Draw :

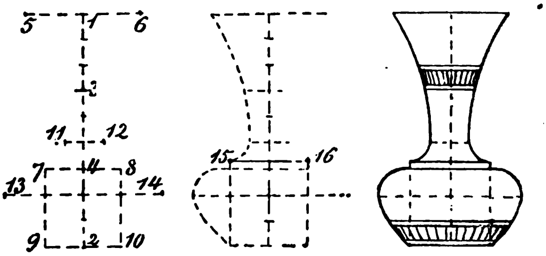
Square = 4″.



789.

You may change the ornaments in pattern 789 for any other made from fig. 786. Those ornaments should be smaller and lighter than the frame lines. Try to have them all alike and of the same size. You may omit some of them, but your work should be *symmetrical.*

Section 102.



(a) (b) 790.

(*a*) Line 1–2 = 6″ divided into 3ds and afterwards into 9ths.
Line 5–6 = 3″.
Lines 7–8 and 9–10 = 2″ each.
Line 11–12 = 1″.
Line 13–14 is nearly 4″.
(*b*) Line 15–16 = 2″. Sketch left side first. Make both sides alike.

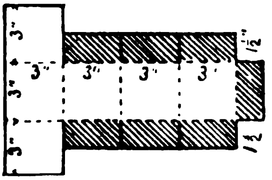
—— Section 103. ——

DRAWING OF SOLIDS.—OBLIQUE PROJECTIONS.*

Models must be used in the drawing of solids. If you cannot make or procure them, do not lose your time in attempting to learn the following sections by simply copying printed sketches.

Models are easily made of paper, soft wood, soap, clay, wax, putty, of soaked peas. and wire or toothpicks, of vegetables like potatoes turnips, etc.

Ordinarily they should be made at home or at recess time.†



791.

THE CUBE.

Paper pattern, fig. 791.
(*a*) Fold paper upon dotted lines.
(*b*) Cut it upon full lines.
(*c*) Shaded surface to be folded in and pasted.

Skeleton pattern made of soaked peas and wooden tooth-picks (or wire).

---

*Although favoring very much *artistic* or *conic perspective*, in model drawing, *industrial* or *cylindrical* perspective, also called *oblique projections*, has been adopted in these Outlines on account of:

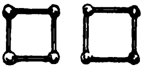
1. The simplicity of its rules and of its execution.
2. Its adaptability to the wants of mechanics who can work from the latter and not from the former.

When public opinion shall give drawing its due place among other studies, more time shall be devoted to this science; then *artistic* as well as *industrial perspective* shall be taught. As it now stands, something has to be sacrificed. The artistic has to yield to the industrial.

† "One half of the difficulty of these drawings will disappear if the teacher has small pieces of wood properly cut for illustration. With a sharp knife they can be quickly made from soft wood. Every school has its boys skilled in the use of the knife, who would be pleased to prepare the models." . . . . "There has been, in schools, altogether too little education of the hand for the good of the head even." . . . . "If the pupil, instead of simply copying the given examples, makes use of models, he will not only draw the example more readily but will be enabled to draw any modifications which may be required." (Charles B. Stetson.)

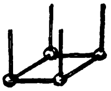
The peas should be soaked over night, and left to dry about one hour before using them.

(*a*) Make two squares.



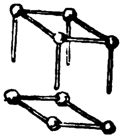
792.

(*b*) Insert perpendicularly a toothpick in each corner of one of the squares lying flat upon the desk.

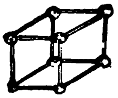


793.

(*c*) Turn this over and insert the other ends of the tooth-picks into the corners of the second square.



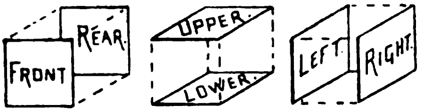
794.



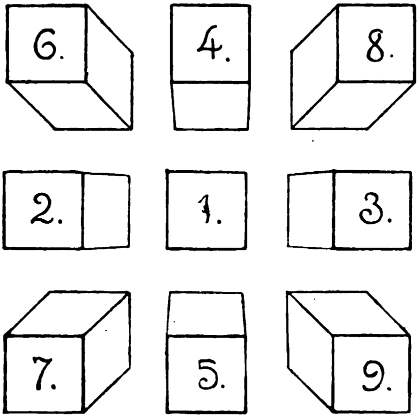
795.

Put a solid cube upon your desk:
How may faces? Count them.
How many edges? Count them.
How many corners or points? Count them.
Name the faces always in the following order:

1. { Front. Rear.
2. { Upper. Lower.
3. { Left. Right.



796.



797.

Now, imagine there is upon your desk a frame (or board), fig. 797, standing vertically, with its center directly opposite your sight, and its lower edge parallel with the upper edge of your desk.

Keeping four faces of the cube vertical, and the front and rear parallel, to the imaginary frame:

(*a*) Move the cube in position 1 (center of board). You see **one face** of the cube only.

(*b*) Move the cube into positions 2, 3, 4 and 5. In each of these positions, you see **two faces**.

(*c*) Moving the cube into positions 6, 7, 8 and 9, you see **three faces**.

Which face do you see in position 1?

Which faces in position 2?—3?—4?—5?—6?—7?—8?—9?

Positions 1, 2, 3, 4 and 5 are seldom drawn, because they do not tell enough about the cube.

RULE 23.

(*a*) Make and use your own models.

(*b*) Do not draw any dot, line or face until you **see** it in the model. Ask yourself: *Which faces do I see?*

(*c*) Ordinarily draw blocks in positions 6, 7, 8 and 9.

(*d*) Make **all** your **oblique lines parallel.**

(*e*) Do not make the farther end of a cube or prism larger than its front.

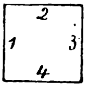
(*f*) When your sketch is made, turn your paper about opposite your eye to obtain different **views** of the model.

To draw a cube:

(*a*) Place your block in position 7 upon your desk.

(*b*) Ask: Which faces do I see? Ans. Front, upper, right faces.

(*c*) Draw front:

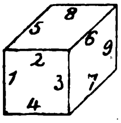


798.

(*d*) Now, taking together the names of the other two faces, *upper—right*, draw your oblique lines towards the **upper right corner** of your paper or blackboard.

Remember to draw your **oblique lines parallel.**

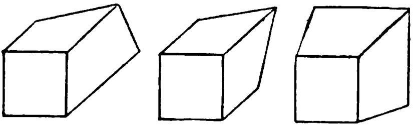
In the cube, make them all of the same length.[*]



799.

(*e*) Make **line 8 parallel to line 2, and line 9 parallel to 3.**

Avoid:

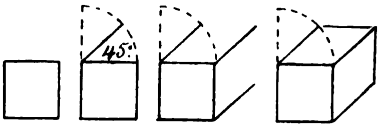


800.

---

[*] In some treatises, oblique lines are more or less shortened. On account of its simplicity, we have adopted the method of Prof. S. E. Warren, making front and oblique lines of an equal length.

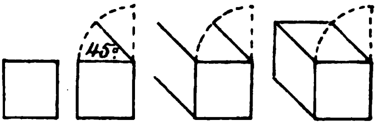
Draw this again, with oblique lines, making angles of 45° with the front lines.



(a) (b) (c) 801.

Move your cube in position 9.

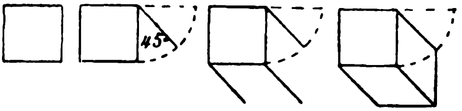
Light and quick work. Which faces? Draw parallel lines.



(a) (b) (c) 802.

In position. 6.

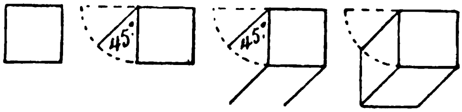
Which faces? Parallel lines.



(a) (b) (c) 803.

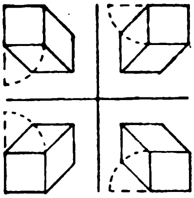
In position 8.

Which faces? Parallel lines.



(a) (b) (c) 804.

In the book:



805.

1 ¼ inch squares and lines.

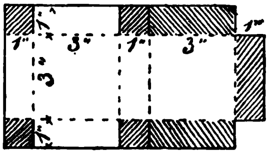
Oblique lines making angles of 45° with front lines.

—— Section 104. ——

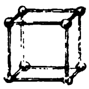
SQUARE PLINTH.

Models:

Paper: Toothpicks and soaked peas or clay.



806.



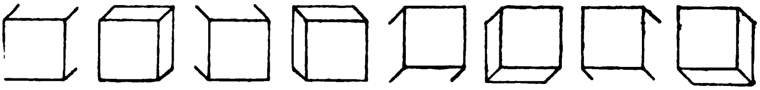
807

Dimensions:
Short lines = 1".
Long lines = 3".

Mount these models like those for the cube, section 103.

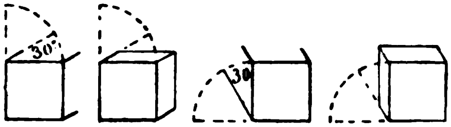
Read rule 23.

Place the model in positions 7, 9, 8, and 6.

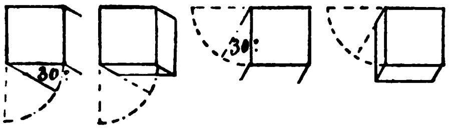


808.

At angles of 30°.

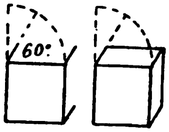


809.



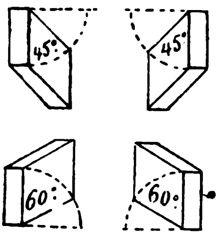
810.

Angles of 60°.



811.

Work in the same manner :



812.

Remember to turn slowly your work at a distance, and notice how the same figure appears to change as each side becomes the lower side of the paper.

In the book :

Copy four views of this block, in positions 6, 7, 8, and 9.

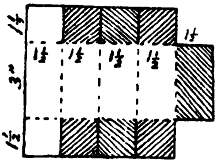
Dimensions : Lines = ½″ and 1½″.

Section 105.

SQUARE PRISM.

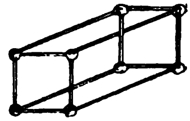
Paper Model :

Skeleton Model :



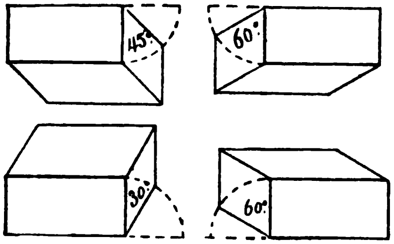
813.

Dimensions 1½″ and 3″.



814.

For mounting, see cube, section 103. Read rule 23.



815.

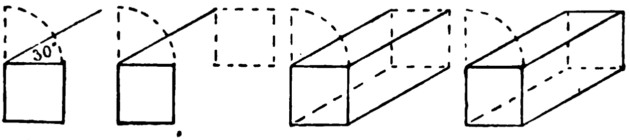
We will call the method we have used so far the 1st method; see fig. 815.

2d method:

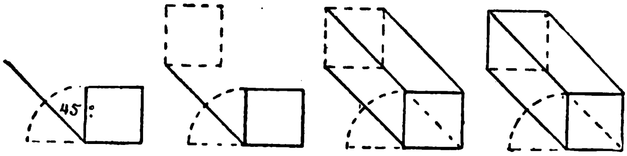
Use skeleton models.

Imagine the block to be transparent like glass (or your skeleton model), permitting you to look through it and to see all its lines and points.

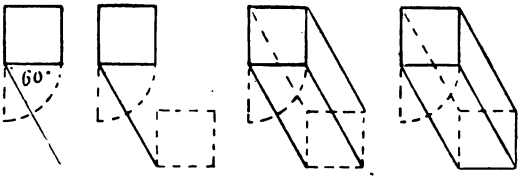
In sketching the following blocks make the front and rear alike. Avoid making the rear larger than the front.



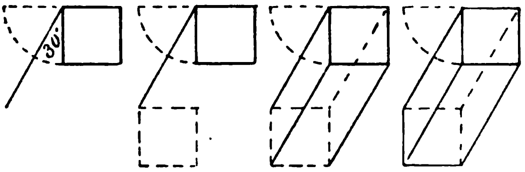
(a) (b) (c) 816.



(a) (b) (c) 817.



(a) (b) (c) 818.



(a) (b) (c) 819.

Use 1st method when the oblique lines are short, and 2d method when the oblique lines are long.

In the book:

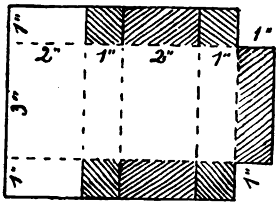
Copy as usual any four of the preceding figures.

Section 106.

OBLONG PRISM.

Mount as usual:

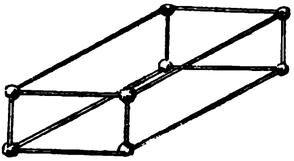
Paper Model:



Dimensions:
1"x 2"x 3".
Any size:
1 x 2 x 3
lengths.

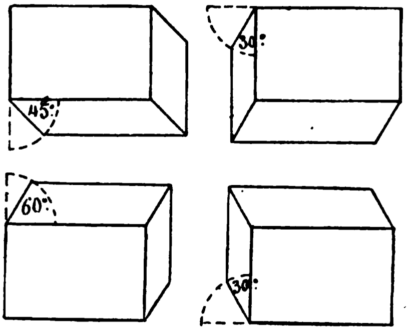
820.

Skeleton Model:



821.

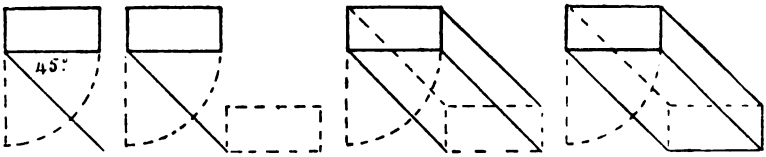
By 1st method:



Which faces?
Parallel lines.

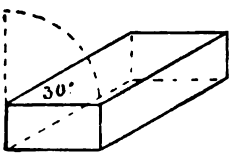
822.

By 2d method:

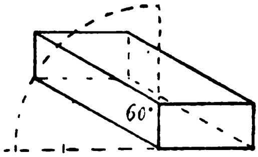


(a) (b) (c) 823.

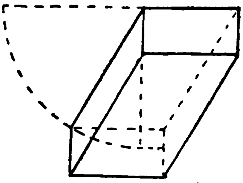
In a like manner:



824.



825.



826.

Turn about for other views.

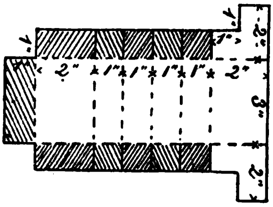
In the book: Copy four views.

Section 107.

Read rule 23.

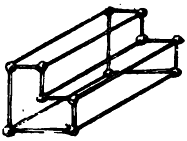
Paper Model.

Skeleton Model.



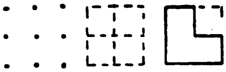
827.

Dimensions:
Lines, 1", 2", and 3".



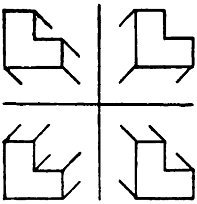
828.

Divide front and draw:

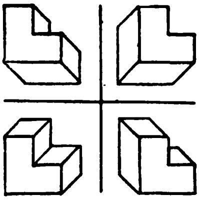


829.

By 1st method:



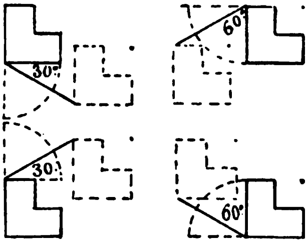
830.



831.

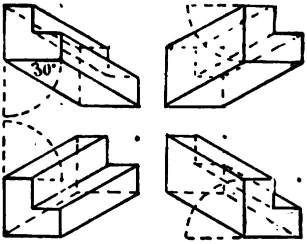
By 2d method:

(a)



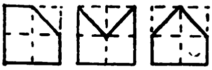
832.

(b)



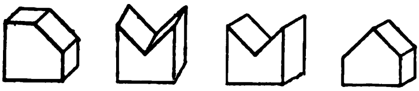
833.

Work in the same manner:



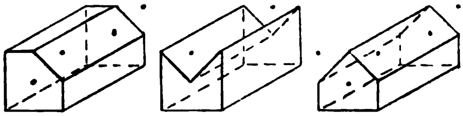
834.

Ex:
1st method:



835.

2d method:



836.

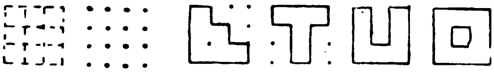
In the book : Sketch four views.

—— Section 108. ——

Read rule 23.

Out of soft wood, soap, clay, etc., make one or more of the following models:

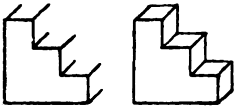
Fronts:



837.

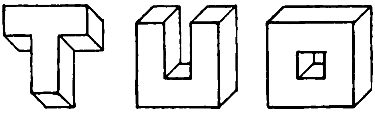
Use 1st method when you have to draw short oblique lines, and 2d method for long oblique lines.

1st method:



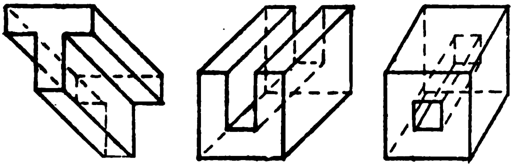
838.

In the same manner:



839.

2d method:



Draw these blocks in positions 6, 7, 8 and 9, so as to see their three dimensions.

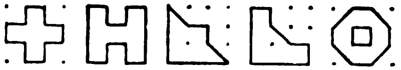
840.

In the book : Sketch four views of these solids.

—— Section 109. ——

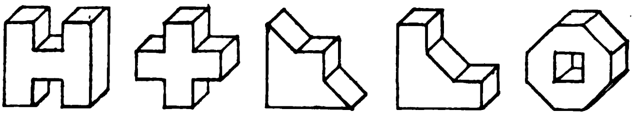
Read rule 23. Make models out of wood, soap, clay, etc. Work as in section 108.

Fronts:



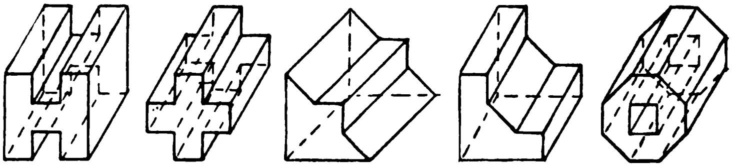
841.

1st method:



842.

2d method:



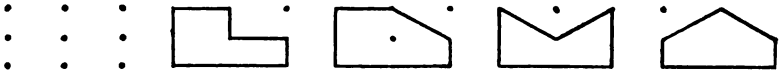
843.

In the book: Sketch four views.

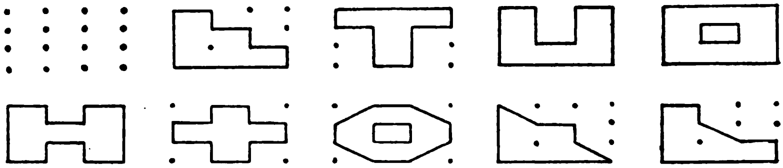
Section 110.

Read rule 23. Make models.

Divide oblongs, and work as you did squares in sections 107, 108, and 109. Ex: Fronts:



844.



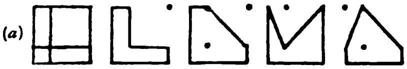
845.

Work by the 1st and 2d methods. Positions 6, 7, 8, and 9. Do not draw all these models.

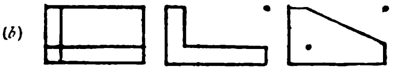
In the book: Copy any four views you like best.

Section 111.

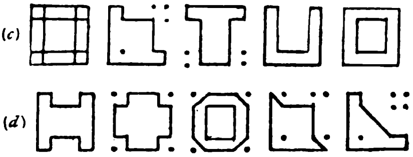
Step by step we are learning how to draw irregular blocks. Many may be made by dividing squares and oblongs unequally. The models used in the preceding paragraphs are altered thus:



846.



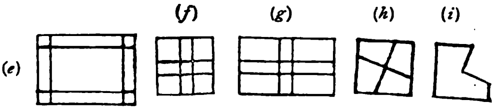
847.



848.

In (*a*), (*b*), (*h*) and (*i*) the fronts are divided into four, and in (*c*), (*d*), (*e*), (*f*) and (*g*) into nine unequal parts.

Select a few of the figures made upon these divisions, and draw them in positions 6, 7, 8, or 9.



849.

Fig. 849 presents new divisions of the fronts.

In the book:
Draw four of your sketches.

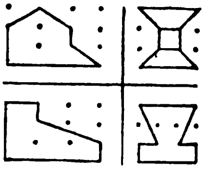
Section 112.

REVIEW

1. Divide a circle into:
   - Quadrants.
   - Sextants.
   - Octants.
2. Can you fit:
   - A square within a circle?
   - A regular octagon within a circle?
   - A regular hexagon within a circle?
   - An equilateral triangle within a circle?
3. Draw in eight different positions:
   - Angles of 90°.
   - Angles of 45°.
   - Angles of 30°.
   - Angles of 60°.
4. Construct:
   - A rhombus upon diagonals 1¾″ and 2¼″ respectively.
   - A rhombus with 2″ sides.
   - A rhomboid with sides respectively 1¾″ and 2½″

5. Construct:
   A rhombus with angles of 45° and 135°.
   A rhomboid with two of its angles of 30°.
   A trapezium with angles of 45° and 60° at the base.
   A trapezoid with angles of 90° and 60° at the base.
6. Draw from memory:
   An ivy leaf.
   A figure with compound curves.
7. Sketch in any of the positions, 6, 7, 8 and 9:
   A block 1"x 1½"x 2½".
   Two steps.
   Three steps.
   The letter H.
   The letter T.
   A cross.

In the book:



850.

Draw several of the foregoing sketches or fig. 850, in positions 6, 7, 8 and 9.

END OF THE FIRST PART.

To avoid fine, this book should be returned on
or before the date last stamped below

50M—9-40

Tx
744.1
G232
pt.1

629009

Garin, P.A.
Outlines of industrial drawing.

DATE	NAME	DATE

TION
VERSI

LIBRARY, SCHOOL OF EDUCATION, STANFORD
629009